Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XL. No. 11. NEW YORK, SATURDAY, MARCH 15, 1902. ISSUED WEEKLY

ELECTRICAL REVIEW
PARK ROW BUILDING
13-21 PARK ROW - - NEW YORK
P. O. BOX 339

BY THE
ELECTRICAL REVIEW PUBLISHING COMPANY
CHARLES W. PRICE
PRESIDENT AND TREASURER
STEPHEN H. GODDARD
SECRETARY
CHARLES T. CHILD
TECHNICAL EDITOR
RUSSELL HOWLAND
GENERAL REPRESENTATIVE

WESTERN OFFICE
1612-1613 MARQUETTE BLDG., CHICAGO
LONDON OFFICE
42 OLD BROAD STREET, LONDON, E. C.

REGISTERED CABLE ADDRESS
"ELECTVIEW" - - NEW YORK
TELEPHONE CALL, 21 "CORTLANDT"
(PRIVATE BRANCH EXCHANGE CONNECTING ALL DEPARTMENTS)

SUBSCRIPTIONS TO THE
ELECTRICAL REVIEW
One Year, United States and Canada - - - $3.00
One Year, Foreign Countries - - - - 5.00
Single Copies, each - - - - - - - - .10
Copies can be supplied for only one year back at 25 cents each

TO ADVERTISERS
CHANGES for advertisements should be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

The proposition to form a National Electrochemical Society similar to the electrical and chemical engineering societies already in existence has met with great encouragement, and at present over three hundred gentlemen have expressed their desire to become members. At the inaugural meeting of the society, which will be held in Philadelphia on Thursday evening, April 3, proper steps will be taken to launch the new enterprise in proper form and to elect its permanent officers. This society will have a field of constantly increasing importance in which to work, and although the wisdom of forming a society separate from the American Institute of Electrical Engineers is perhaps open to debate, yet it is indubitable that the new body will find much work to do and give the opportunity for original papers of a most interesting and valuable character.

WIRELESS TELEGRAPHY AND CABLE STOCKS.

History has a habit of repeating itself. Upon the advent of railroads seventy years ago the tremendous fever of speculation which arose in the shares of railway companies was preceded by a panic among the holders of stocks in turnpike and stage-coach companies. The introduction of electric lighting from central stations in 1884 created an almost irrepressible panic among holders of gas securities, and many gloomily predicted the entire supercession of the gas-lighting industry with the consequent loss of all the moneys that had been invested in it. On the contrary, gas companies are doing better to-day than they ever did before, while electric light companies are also making a fair living.

The telephone had no sooner been found practicable than the same unreasonable alarm seized upon holders of stock certificates in the various telegraph companies, causing many of them to sell at a loss, and again predictions were freely made that the telegraph would be superseded and that its day was over. Again on the contrary, the telegraph companies are doing more business to-day than they ever did before, and are finding the telephone a convenient adjunct and assistant rather than an active and costly competitor.

Every time the newspapers chronicle some new feat of wireless telegraphy shares of the various cable telegraph companies exhibit a decline (small, to be sure, but nevertheless a decline) on the various stock markets of the world. If investors would only stop to think and look back upon the history of similar enterprises they would feel sure that, far from being a competitor of a hurtful kind, wireless telegraphy will unquestionably do more good than harm to existing cable companies.

The most immediate and apparent use for the Marconi method of signaling is for maritime news reports of incoming vessels and conversations between ships at sea and between the shore and such ships. With none of these things has the cable company directly anything to do. If a ship, for example, from an European port is approaching New York and is reported by the marine observer, the news of its arrival is telegraphed by land wires to the offices of the navigation company and by them at once cabled to the place from which the ship started. Any method, therefore, of improving and increasing the volume of incoming ship reports necessarily will add to the bulk of business traveling over the cables. To-day if a Cunard steamship passes Fire Island, that fact, together with the time, is all the information that the observer stationed at that point can give and naturally is all that can be cabled back to the home port. But such a ship passing the wireless station on the Nantucket lightship, for example, may not only report its arrival and time, but may offer for transmission numerous messages of one sort or another which are to be cabled back to Europe. In this way the immediate effect of the installation of ship-reporting stations is to increase the cable companies' business and tolls.

In another and indirect way the added safety to navigation which is probably to be brought about by the widespread use of wireless telegraphy will increase the volume of shipment, will make more business, will diminish insurance rates and, as a consequence, react for the better upon the business of the cable companies. So far, then, every development of the new system appears to be a benefit rather than a detriment to the existing cable lines.

But it is stated on good authority that an attempt will be made to compete for transatlantic through business by means of wireless telegraphy as against the existing cables. No doubt experiments of great interest and possibly of potential value will be carried on, but can the cable companies seriously view with apprehension even the successful establishment of such a

method of signaling? The capacity of the present transatlantic cables is by no means exhausted. Their total probable maximum working capacity is in the neighborhood of nine hundred words a minute both ways, this assuming that they all work duplex at a speed of somewhat less than twenty words a minute. This means a total during a day of over a million and a quarter words or, at average rates, an income of about a quarter of a million dollars a day. It is not believed that this limit has been reached nor does it seem probable, in the light of existing information, that the competition of wireless telegraphy will be in any degree serious. Assuming even the somewhat remote possibility of the establishment of tuned systems for such work, it is not conceivable that more than a certain small number of these could operate simultaneously, nor does the speed attainable in wireless telegraphy seem to be much, if any, greater than that usual on the transatlantic cables. Certainly there will be business enough for both; and even if a commercial business of wireless transoceanic telegraphy is inaugurated, it is beyond doubt that the history of the apparent conflict between electric light and gas, and that between the telephone and telegraph, will repeat itself. Certainly up to the present the cable companies have made money out of wireless telegraphy.

THE BROOKLYN BRIDGE PROBLEM.

There is a considerable agitation now going on concerning the problem of bettering the facilities for transit between New York and Brooklyn, especially those using the existing bridge. Through the narrow and constricted artery of this bridge there pours at certain times of the day an enormous and unprecedented swarm of human beings, with the result that the terminals are outrageously and even dangerously congested, that people are hurt in wild scrambles for cars, and that, in plain words, the whole situation has become an unmitigated nuisance. To attempt its betterment a number of plans have been suggested, but among them all the most transcendental and extraordinary is that proposed by Bridge Commissioner Lindenthal. This is nothing less than the establishment of moving walkways running from a loop at one end of the bridge to a loop at the other at various speeds, so that people might conveniently be accelerated in walking over the bridge. Probably no more amazing and astonishing scheme was ever proposed by mortal man. Let the imagination conceive some denizen of the upper counties of New York attempting for the first time to surmount the moving walkway, and getting inextricably tangled up between the various walks going at various speeds, and apparently (when one is on the middle one) in all directions. The result would be interesting but unpleasant. The establishment of such a system, so long as it worked, would furnish the population in New York with an immense amount of free amusement at the expense of those who tried to use the thing, but it is very doubtful if it would go far toward solving the transit problem.

Seriously speaking, the weak point of any moving walkway system lies in the innumerable wheels and journals that have to be kept in repair and in the fact that an accident anywhere along the line of moving walkways would stop the whole thing. Indeed, a derailment or a serious breakage would probably result in piling up several hundred yards of it in a wreck such as can only be imagined by old railroad men.

The moving walkway, as the fertile imagination of Mr. H. G. Wells suggests, may be a recognized element of transportation in the future, but it certainly does not belong to the present. The solution of the Brooklyn Bridge and traction problem which seems most promising at present is the construction of tunnels under the East River. Such tunnels could be built in less time and for less money than more bridges. It is not believed by those who have closely studied the transit situation in Greater New York that the new bridges now in course of building will do much to relieve the congestion at the terminals of the present bridge. For years lines of travel have shaped themselves to include the present structure, and the growth of Brooklyn particularly has been with reference to the existence and use of that particular line of communication. It seems, therefore, that tunnels somewhere in the vicinity of the present bridge would be the quickest and easiest solution to make. There is some talk, of course, of popular prejudice against descending into the bowels of the earth or traveling under a deep river in a tunnel, but even this seems infinitely preferable to a fight for life at the crowded terminals of the bridge such as is the almost daily experience of those compelled to use it.

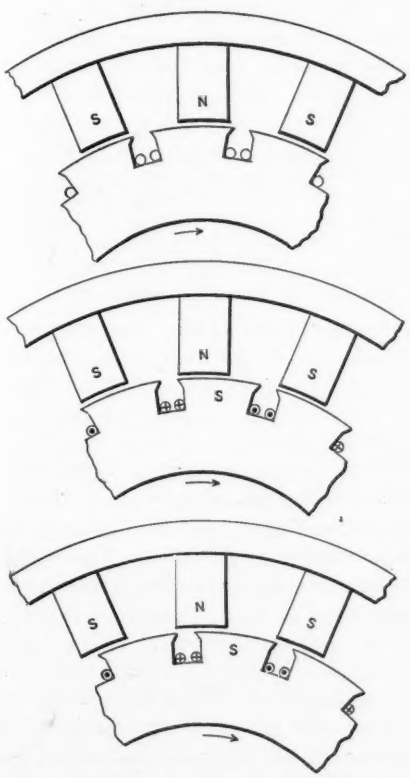
In the average American city the total volume of energy consumed in warm weather for driving electric fans is by no means inconsiderable. Indeed, these fans offer one of the most desirable varieties of load for central stations since they operate for the most part in the daytime and on long hours. Station managers who will carefully investigate the subject of fans will probably find it considerably to their interest to encourage as much as possible the use of fans by their customers, even to the point of renting the fans at a nominal rental per month to those who do not wish to make the necessary investment to acquire their own fans. On alternating-current supply the power-factor of small fans is not particularly good, but doubtless some arrangement could be made to prevent any trouble due to a considerable load of such apparatus on the circuits.

The electric light sign, whatever may be said about it with an eye to its appearance and æsthetic value, appears to have come to stay and to be very popular. The use of these signs can be greatly encouraged by central stations which will take up the subject and investigate it with a view to the local conditions. The Chicago Edison Company has added a very large amount of sign lighting to its circuits by the use of standard types of signs which the company makes and rents to its customers complete, the rent including the use of the sign and the current necessary to illuminate it during certain hours. These signs take a large variety of forms, the standard types ranging from those employing five lamps to those using upward of one hundred. Unlike the fan motor, however, the electric sign is not a load which comes at the hours of light consumption but burns straight through the peak of the evening load which fact must, of course, be reckoned with in exploiting its use.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LX.

BY W. ELWELL GOLDSBOROUGH.

A study of equations (155) and (156) shows that, when the capacity reactance factor neutralizes the armature inductance reactance factor, the current will be a maximum, and in phase with the total internal electro-motive force; and again, that when the capacity reactance of the receiver circuit overpowers the inductance reactance of the armature, the current will take a position in advance of the total internal electro-motive force OA_0. To bring out these points more clearly, we will study the phase diagrams 145 and 149. Suppose, for instance, that C_1 and x_1 are given such values that the current assumes the phase position of OB^c in Fig. 145. In this case, by extending the line OB^c to the semicircle described on OA_0 as a diameter, we determine the value of the electro-motive force in phase with the current. The vector distance $C_0{}^cA_0$ will be equal to the effective reactance electro-motive force of the circuit, or it will be equal to $C_0{}^cA_0 = I^c x_1 - I^c x_a = C_0{}^cF^c - A_0F^c$.



FIGS. 146, 147, 148.—ALTERNATING-CURRENT MECHANISMS.

That this construction is correct can readily be seen by following out the effect produced by the magnetizing power of an armature coil. The armature current, OB^c, which attains its position in advance of OA_0, on account of the fact that the capacity reactance of the receiver circuit is greater than the inductance reactance of the armature, creates a magnetic field in phase with itself. This is shown by the vector M^cM_0. Now, this flux is

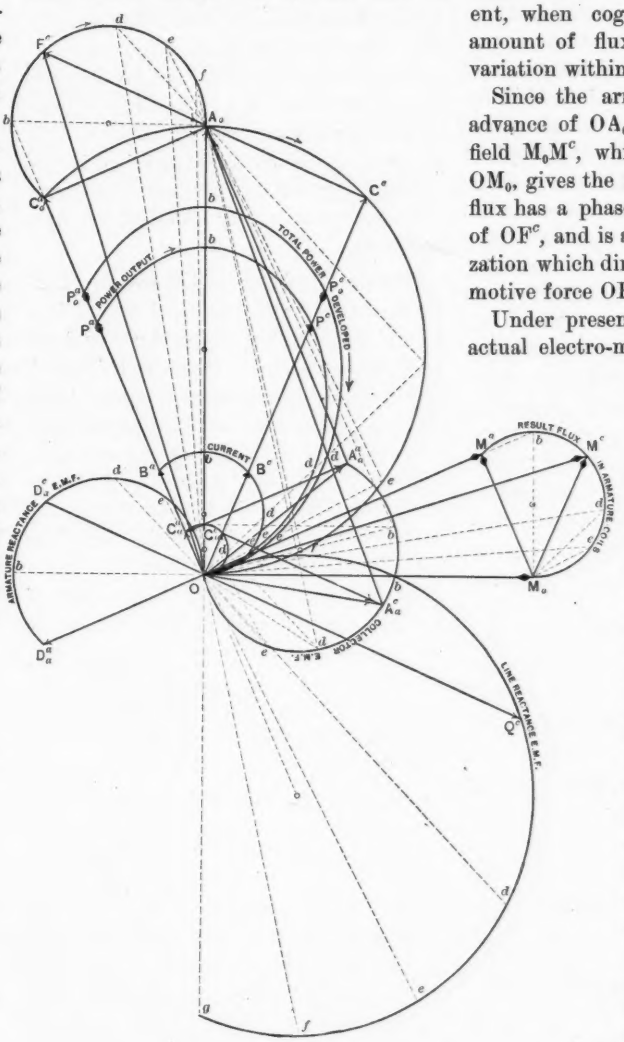


FIG. 149.—ALTERNATING-CURRENT MECHANISMS.

cyclicly enclosed by the armature coil, and thereby induces in it a reactive electro-motive force, having a phase position 90° behind the current. We can, therefore, designate it as the vector $OD_a{}^c$, lagging 90° behind OB^c. Now, A_0F^c is equal and parallel to $OD_a{}^c$, and the position of $OC_a{}^c$ is fixed; consequently, the reactance electro-motive force of the receiver circuit must be sufficient to span the distance $C_0{}^cA_0$, in addition to neutralizing the electro-motive force $OD_a{}^c = A_0F^c$.

If we sum up the vectors which, combined, make the electro-motive force actually developed in the armature windings, we take the resultant of $OC_0{}^c$ and $C_0{}^cF^c$, since the current flowing in the receiver circuit is forced through r_1 and x_1 by the electro-motive force active between O and A, Fig. 144, which must be sufficient to overcome the impedance of r_a, r_1 and x_1 combined. The reason for this electro-motive force OF^c being greater than the electro-motive force $E_0 = OA_0$ is at once apparent, when cognizance is taken of the amount of flux now undergoing cyclic variation within the armature coils.

Since the armature current OB^c is in advance of OA_0, it produces a magnetic field M_0M^c, which, when combined with OM_0, gives the resultant flux OM^c. This flux has a phase position 90° in advance of OF^c, and is a measure of the magnetization which directly produces the electro-motive force OF^c.

Under present conditions, OF^c is the actual electro-motive force developed in the armature coils by the resultant flux penetrating those coils. OA_0 has no real value, and should a rupture take place in the insulation of the armature, it would be a rupture due to a real electro-motive force, of which OF^c is a measure, and which is induced by the resultant flux OM^c. The projection of M_0M^c on OM_0 shows clearly that when the capacity reactance of the receiver circuit is large, the armature current increases rather than diminishes the total flux penetrating a field coil.

Figs. 146, 147 and 148 point out somewhat more clearly the reason for these effects. In Fig. 145, the current OB^c has a phase position 24° in advance of OA_0. The current will, therefore, be zero, when the armature coils are in the position which they are shown to occupy in Fig. 146. At this time of zero current, the total internal electro-motive force will have a negative value that is approaching zero. When the teeth advance to the position which is shown in Fig. 147, the current will have risen to a considerable positive value, and the total internal electro-motive force will have just been turned positive.

A further advance in the position of the teeth to that shown in Fig. 148 brings the current to a maximum positive value, and leaves the total internal electro-motive force still rising positively. Thus it is seen that, at the time the current is approaching its maximum power, the teeth are so situated that the field which the current in the coils creates directly assists the magnetism produced by the current in the field coils. So much for the presentation of the vector quantities in their relative phase positions and values.

Science Brevities

Aluminum Bronzes Under Test—At the request of the Neuhausen Aluminum Company, which provided the samples, an account of the tests of aluminum bronzes carried out in the Zurich Polytechnic School, has recently been published by Mr. Tetmayer. Commenting on this the London *Electrical Engineer* says that the specific gravity first rises and then falls as the percentage of aluminum increases. The maximum strength for soft alloys was obtained with 3.4 per cent Al, and for hard alloys with 1.4 per cent Al. For brass, the electricity decreases with the increase of Al, and is extremely low with two per cent of the latter. Silicon increases the specific gravity and reduces the elasticity. Iron, in the proportion in which it was present in the alloys, was not observed to sensibly influence the physical characteristics. Aluminum bronze, containing ten per cent Al with 1.5 per cent Si and Fe, is too brittle to be of any practical value. As regards the abrasion by friction, the hard alloys, with less than 89.6 per cent Cu, lose little in weight, while the soft alloys, with less than six per cent Al, heat and wear away rapidly.

Electric Waves from the Sun—C. Nordmann has made some experiments for the purpose of finding whether the sun emits electromagnetic rays, or rather, whether such rays are capable of penetrating to the surface of the earth. These experiments were made by M. Nordmann in the course of his mission to the Mont Blanc Observatory. The London *Electrician* abstracts an account of this as follows: It is reasonable to suppose that electromagnetic waves of the Hertzian kind are actually sent out, but it is very doubtful whether they can reach any observatory on the earth. In order to obtain the best conditions it is necessary to choose the highest possible elevation, so as to escape the absorbing action of the atmosphere and of aqueous vapor. The author, therefore, conducted the experiments at the station of Grands-Mulets, at an altitude of 3,100 metres. A spell of bad weather prevented him from conducting the experiments at the top of Mont Blanc itself. The receiver used consisted of a galvanometer circuit with coherer, and an antenna 175 metres long, stretched over the Bossons Glacier, in such a position that at midday the sun's rays fell upon it vertically. This had the double advantage of protecting the wire from the electric waves emitted by the Chamounix railway, and from the interference of waves which would have been reflected by the ground if the soil had been a conductor instead of a non-conducting glacier. The results of the experiments, made under a cloudless sky on September 19, were entirely negative. The sun, therefore, either does not send out waves of this order, or they are completely absorbed by the sun's atmosphere or by the upper strata of the earth's atmosphere. Such an absorption is exceedingly probable, as we know that Hertzian waves are largely absorbed by rarefied gases.

Electric Resistance Laboratory Furnace—Professor Holborn, of the Reichsanstalt, Berlin, has designed a new form of electric resistance laboratory furnace, which permits temperatures up to 1,500 degrees centigrade to be attained with ease by use of the ordinary 110-volt electric supply. These furnaces, as described in *Nature,* are made in two forms, the first being adapted for heating crucibles and the second for heating tubes forty-four cm. in length. Both forms of furnace are alike in principle, the electric current being conducted through a resistance coil of platinum or nickel wire, wound round a thin porcelain tube or cylinder. The crucible or substance to be heated is placed within this latter, and the space between the outer side of the coil and the containing-vessel is packed with asbestos or powdered quartz. Using nickel, the temperature of the furnace can not be raised above 1,000 degrees centigrade without damage to the coil, but with platinum it is possible to attain a temperature of 1,500 degrees centigrade with a current of 14 amperes and 110 volts. It is necessary in the use of these furnaces to include a resistance in the circuit and to use only one-half of the maximum current when the heating is first commenced. The use of exterior resistance enables the temperature of the furnace to be regulated with ease, within somewhat narrow limits. Further advantages claimed for these furnaces are—that the separate portions are replaceable when worn out, that the heating spirals can be easily removed and changed to suit the special temperatures required, and that with the tube form of furnace the heating of the substance can be carried on in the absence of air and in the presence of any desired gas or gaseous mixture. It would be interesting to know whether any attempts have been made to apply electrical resistance heating to organic combustion work. The usual type of gas-heated combustion furnace is capable of improvement, and the substitution of electricity for gas would bring with it some notable advantages. In localities where the day supply of electricity is at reduced rates this application is worthy of attention.

A Phenomenon of Combustion—M. Trillat, a French scientist, has recently reported the discovery of a curious phenomenon in connection with the glowing of metals in gases, analogous to some extent to the luminous effect produced when a piece of spongy platinum is immersed in a jet of hydrogen or coal gas. If a spiral of platinum be placed in a glass tube, says a British contemporary, and an electric current passed through it so as to raise its temperature to a certain point, say a dark-red heat, then if alcohol vapor or vapor mixed with air is passed through the tube, the wire will continue to glow without the aid of the current, simply as a result of the presence of the gas in contact. The peculiar point about the matter, however, is that if, instead of being raised to, say, a dark red, the temperature be raised to, say, a cherry red, by the aid of the electric current in the first instance, it will, after the current is turned off, remain at this higher temperature. It is this selective influence as regards temperature that seems so strange and so far difficult of explanation, and the fact that when the phenomenon has been started at a given temperature several times in succession, it is not necessary to use the current at all in commencing the reaction, which then takes place, as it were, automatically at a fixed temperature. According to the authority quoted, the effect is not confined to platinum, but may also be produced with wires of silver, iron and copper.

Theory of Fluorescence—A short abstract of a paper on this subject appears in a recent issue of the *Journal* of the Chemical Society. Fluorescent and phosphorescent phenomena are due to free, incoherent vibrations within the excited substance. The author discusses the electron theory, and from results so far obtained concludes that the molecules of fluorescing substances are capable of existing in two conditions, in which the electrons have different periods of vibration. The change from one state to the other is conditioned by molecular relationships, but an exciting light wave has also the power of aiding or starting the transition. The electrons pass into the new condition with speeds and elongations which are influenced by the motion given to them by the exciting wave in the old condition, and they perform free, incoherent vibrations with a period corresponding with the new condition. The periods of vibration in the two conditions are very different, and one is damped to a much greater extent than the other.

The Berlin-Zossen High-Speed Electric Railway Experiments—II.

By Enrico Bignami.

The main transformers are constructed so that the three cores lie in the same plane. In order to obtain good ventilation of these transformers they are arranged with their longitudinal axes in the direction of movement of the car. The primary circuit receives the 10,000-volt current directly and is permanently star-connected. Between the transformers and the current-taking devices is interposed a high-tension switch for handling the primary current. All of the circuits connecting the high-tension switch and its transformers are of bare copper, run on high-tension insulators. Upon the walls of the end rooms of the car are mounted two metallic cases, each containing a small three-core transformer for the air-pump motor and a high-tension switch. These same switches are also used in making connections for reverse movement of the car. (Fig. 7.)

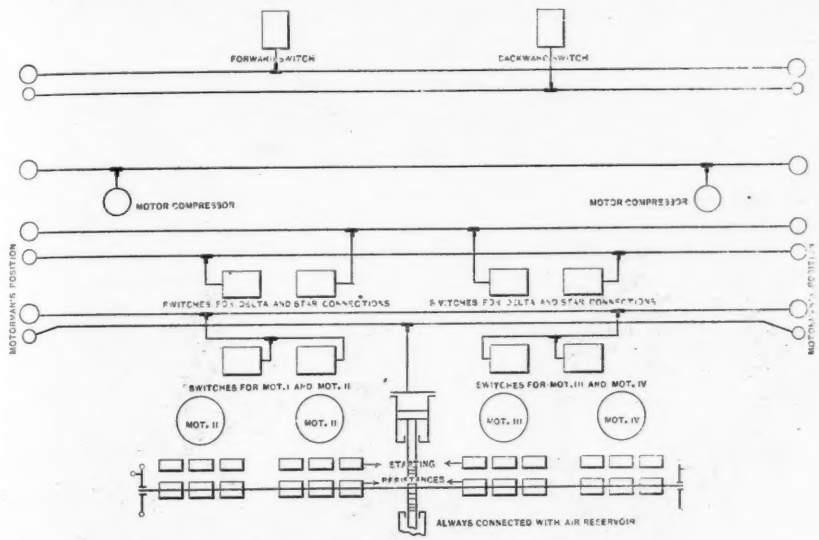


FIG. 7.—ARRANGEMENT OF SWITCHES.

The current-taking contacts on such a piece of apparatus should naturally work without sparks. They should also be placed at considerable distance from one another. Since the three trolley wires are placed at one side of the track, above one another, the bow trolleys which are used are arranged to play in a horizontal plane and to turn upon a vertical axis. The part of the bow in contact with the wire is thus vertical and is made fairly rigid. The axis of the current-taking system is mounted immediately above the king-pin at each end of the car, so that the lateral swaying of the trolleys is not too great for successful contact. The control and manœuvering apparatus for these trolleys is in the motorman's cab and is adapted to be turned to one side or the other for the forward or backward movements of the car. From the bows the current passes through slip rings and brushes to the high-tension bare conductors on the roof of the car and thence to the high-tension switches. All of the upper part of the contact-making arrangement is removable, the axis or shaft alone being fixed to the roof of the car, where it passes through a collar and down to a bearing below, so arranged that the rod may be turned when the direction of motion is reversed. Fig. 8 gives an excellent idea of the general apparatus of one of these three-part trolleys.

The air pumps are located in the motormen's cabs and are fed by the small transformers mentioned above, these working from 10,000 volts to 110 volts, three-phase. In the cabs toward the front of the car are found, also, valves for the control of the auxiliary apparatus by means of the compressed air. Upon the same control table is placed also the valve for the air brake as well as the cut-off valve for the air pump, while near by are the indicating apparatus or pressure gauges and speed gauges.

THE OVERHEAD CONDUCTING SYSTEM.

The three wires of the conducting system are mounted on poles at one side of the track, these being set at a normal distance of eight feet three inches from the centre of the track. The three wires are situated one above the other at a distance of one metre (thirty-nine and three-eighths inches) apart, the lower wire being strung eighteen feet above the level of the track.

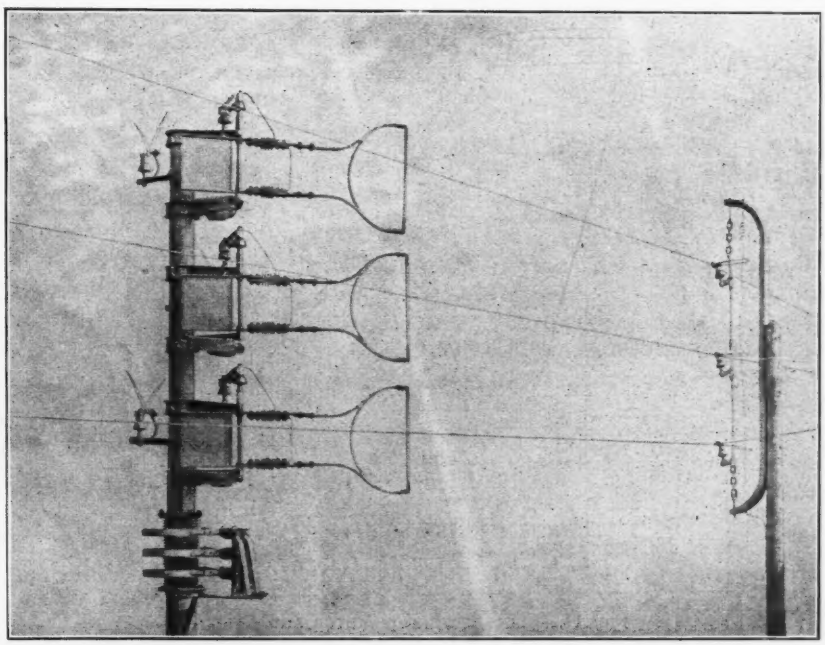


FIG. 8.—DETAIL OF TROLLEY AND CONDUCTING SYSTEM.

The entire line is divided into sections of one kilometre (0.62 mile) long and the neutral point of the three-phase high-voltage system of currents employed on the

conductors is grounded and connected to the rails.

MOTORS.

Each of the motors upon the car is capable of developing normally during

FIG. 9.—DETAIL OF THE STATOR OF ONE OF THE DRIVING THREE-PHASE MOTORS.

operation 250 horse-power, and during starting about 750 horse-power. The motor is entirely contained in the space between the wheels and has a sufficient clearance above the track to avoid striking any part of the road-bed. The weight of each motor without its axle is 8,800 pounds.

The motors are of the six-pole type and work at 900 revolutions per minute. It was decided to mount the motors directly upon the axles rather than to attempt any kind of gear transmission, although experiments undertaken with the latter show that it was possible, even with a velocity of the teeth as high as eighty feet per second. An extended description of the tests that were made on this point would lead us too far from our subject, but it may be mentioned here that 120 horse-power was transmitted during a period of three hours at a speed of 850 revolutions per minute without sensible heating of the gear or of the oil which was constantly sprayed in by compressed air between the teeth.

The iron of the stationary part of the motor is ring-formed and is made of continuous rings. Figs. 9 and 10 give some details of these motors.

On the lower halves of the support plates are cast two lugs upon which are bolted steel bars to which the spring suspension for the motor is attached. The winding of the motor is comprised in ninety primary slots and seventy-two slots in the secondary element.

These motors are of an inverted type of construction, in which the rotating element is the primary and the stationary element the secondary. Since the frequency of the currents in the secondary element is large only during the time of starting, and is very small when full speed is attained, this part of the motor needs to have a radial dimension less than that of the primary part. On this account the diameter of the rotor is made 780 millimetres (twenty-five and one-half inches), while the total diameter of the motor over all is only thirty-four and one-half inches. The general design of the motor is well shown in the cross-section of Fig. 11.

The primary winding is arranged to take the secondary pressure of 1,150 to 1,850 volts from the main transformers directly into the turning part of the motor. This is accomplished through three slide rings placed at one end of the shaft, upon each of these rings eight carbon brushes being employed. All of the discs comprising the iron part of the rotor are stamped each in a single piece.

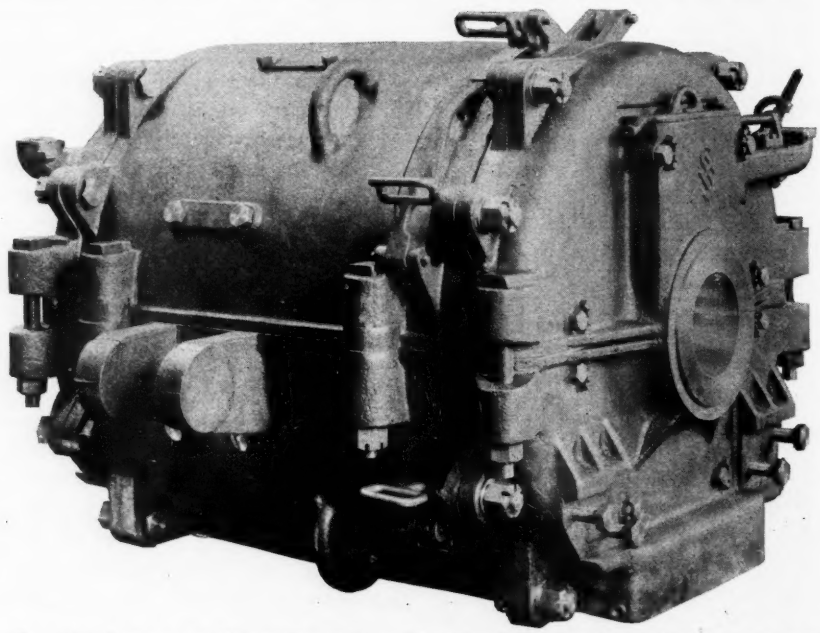


FIG. 10.—ONE OF THE THREE-PHASE AXLE-MOUNTED 250-HORSE-POWER MOTORS FOR THE BERLIN-ZOSSEN EXPERIMENT.

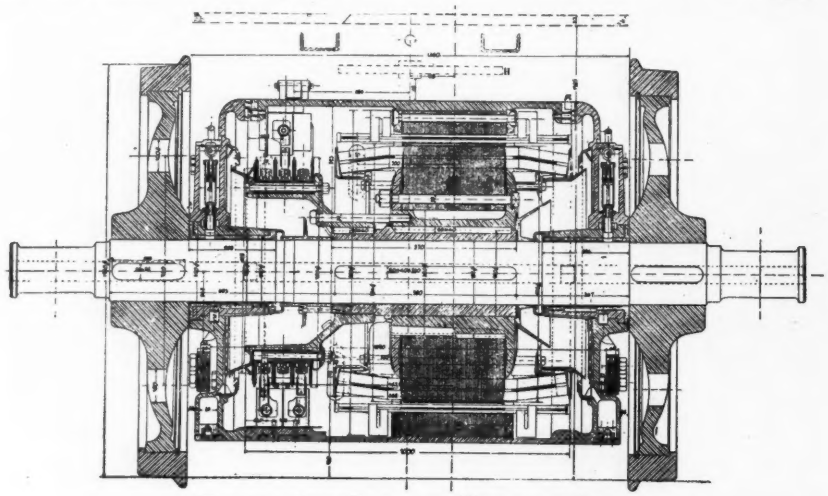


FIG. 11.—CROSS-SECTION OF MOTOR AND AXLE.

The winding of the rotor is of the ordinary kind used for the direct current and is composed of bars, as is shown in Fig. 12 very clearly. The conductors are laid in mica troughs in the slots, as the illustration clearly shows.

The winding of the stationary part is of the bar type as is usual in three-phase machines. The lead wires, both primary and secondary, going into the motor are carefully insulated by hard rubber bushings. In Fig. 13 is very clearly shown a truck with its two motors mounted in place.

RHEOSTATS AND STARTING APPARATUS.

As was stated above, the power of each motor during starting is 750 horse-power, while at normal running speed it is 250

horse-power. In handling currents of such power it is, of course, necessary to divide the rheostats employed so that cutting out sections one at a time will not result in heavy sparks or arcing. In the adopted design the rheostats were divided into twenty-nine sections for each phase, of which four were reserved for the first starting steps and the other twenty-five for the regulation of the speed. This means that each section cuts in or out about twenty horse-power of energy, which is not excessive as has been proven in other installations.

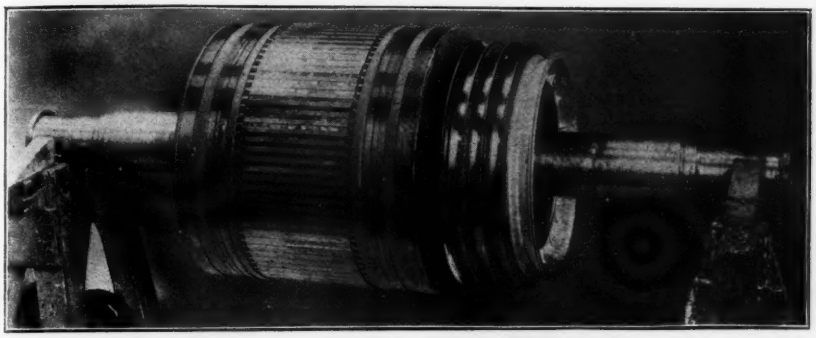


FIG. 12.—REVOLVING PRIMARY OF ONE OF THE THREE-PHASE MOTORS.

three large resistances for each motor. The small resistances are reserved for the first starting effort, while the larger resistances comprehend twenty-five other sections. They do not differ among themselves in method of construction but only in dimensions.

The resistance boxes are built of angle iron and are attached between the lower frame of the car body and the lower sills of the windows. These boxes are covered with sheet metal protecting plates, which are cut into vertical slats so as to catch the air and cause a powerful circulation over the resistance metal while the car is in motion. (See Fig. 14.)

The resistance material consists of straps of a peculiar alloy known as "kruppine," the cross-section being one and one-half by one-twelfth inch, and the straps being arranged vertically in pairs and run in the form of a double ribbon between porcelain knobs attached to longitudinal bolts. Since for each phase of each motor there is a rheostat, it is necessary, of course, that there should be a sectional switch for each of these, thus necessitating three controller cylinders for each motor or six on each side of the car. These cylinders are arranged parallel to the length of the car immediately under the large resistance boxes (Fig. 15). These cylinders are set upon their axles so that all rotate together and are furnished with connecting strips of bronze, arranged helically on the surface of the cylinders and adapted to be easily removed if worn or burned.

The working of the controller cylinders placed under the sides of the car is accomplished in the following way: Under the floor of the car and running along from end to end under the middle of it is a steel shaft connecting the two motormen's positions, which may be called the control shaft. This is connected through four strong sprocket chains with the four shafts of the controllers. The control shaft carries two locking wheels to indicate the closing of the different contacts and can be worked from either of the two cabs by means of a bevel-gear and a handwheel, or by an indirect system using compressed air.

The latter arrangement consists of two cylinders working one against the other, of which one is larger than the other. The smaller cylinder is always under pressure, while compressed air is admitted into the

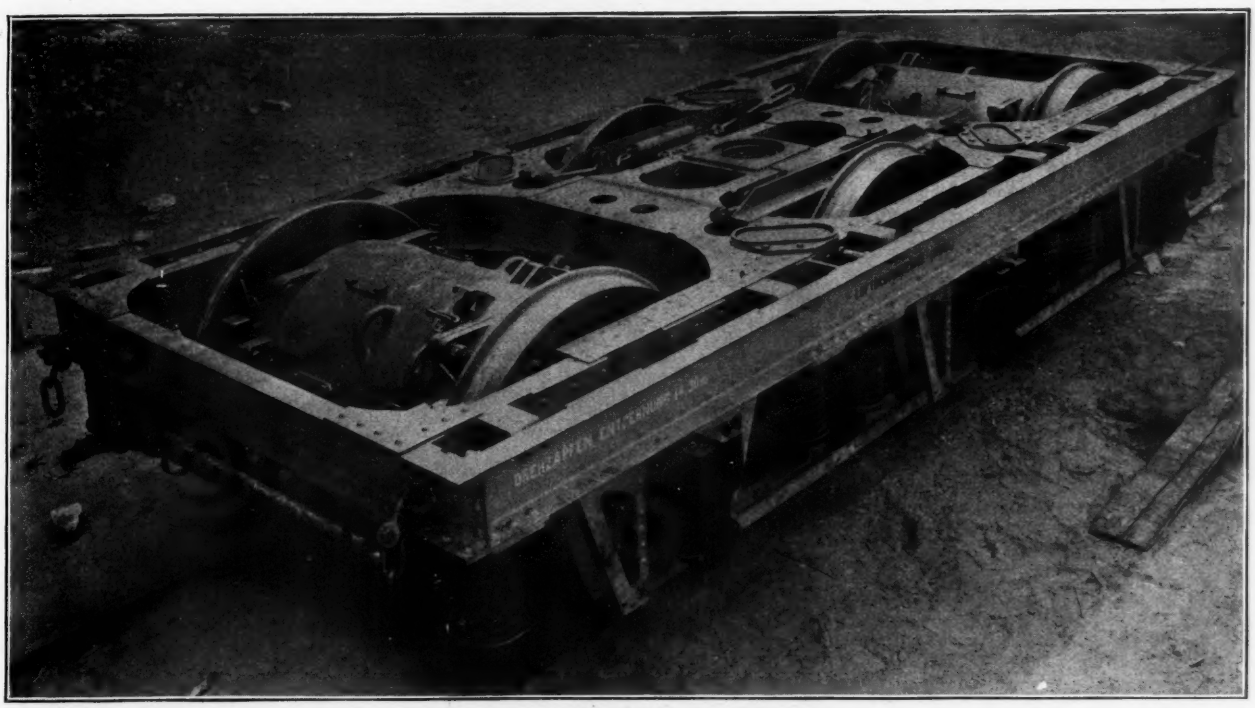


FIG. 13.—COMPLETE SIX-WHEEL TRUCK WITH TWO MOTORS IN PLACE.

Since the space under the car was already well occupied by transformers and by control apparatus it was determined to put the rheostats and starters in the side walls of the car body.

For each phase of each of the motors there was built a small resistance and a large resistance, in all three small and

other only at the moment of starting. The pistons of the two cylinders are rigidly connected by means of a rod carrying a rack acting upon a pinion placed upon the control shaft. During the starting of the motors the large cylinder works against the small one and aids the motorman in turning the shaft. In stopping or slowing down, when resistance is being coupled in before the motors are disconnected, the air is released from the large cylinder and the small one works to turn the shaft the other way without the motorman being obliged to make any motions. In other words, by turning the air out of the large cylinder the small cylinder immediately throws the shaft over to the stop position.

The medium-tension switches are of a patented type which is well known. They are worked by compressed-air pistons, and contact is broken in an air-tight insulated tube where the extinction of the arc is accomplished by rings of cooling metals. For each phase there is a two-pole switch giving a total length of break of nine inches. The six contacts necessary for this arrangement are arranged at the angles of a regular hexagon, the control cylinder being placed vertically at its centre, as is shown in Fig. 16. The movable parts of the contacts are arranged upon a sort of bridge which is raised or lowered by the piston of the air cylinder. The connection between the piston and this bridge is not entirely rigid. An arrangement for instantaneously making and breaking contact, consisting of a locking device which is held at one or the other of the limits of motion of the piston and a spring, are included between them. All the parts exposed to current or wear on these switches are so arranged as easily to be replaced if necessary.

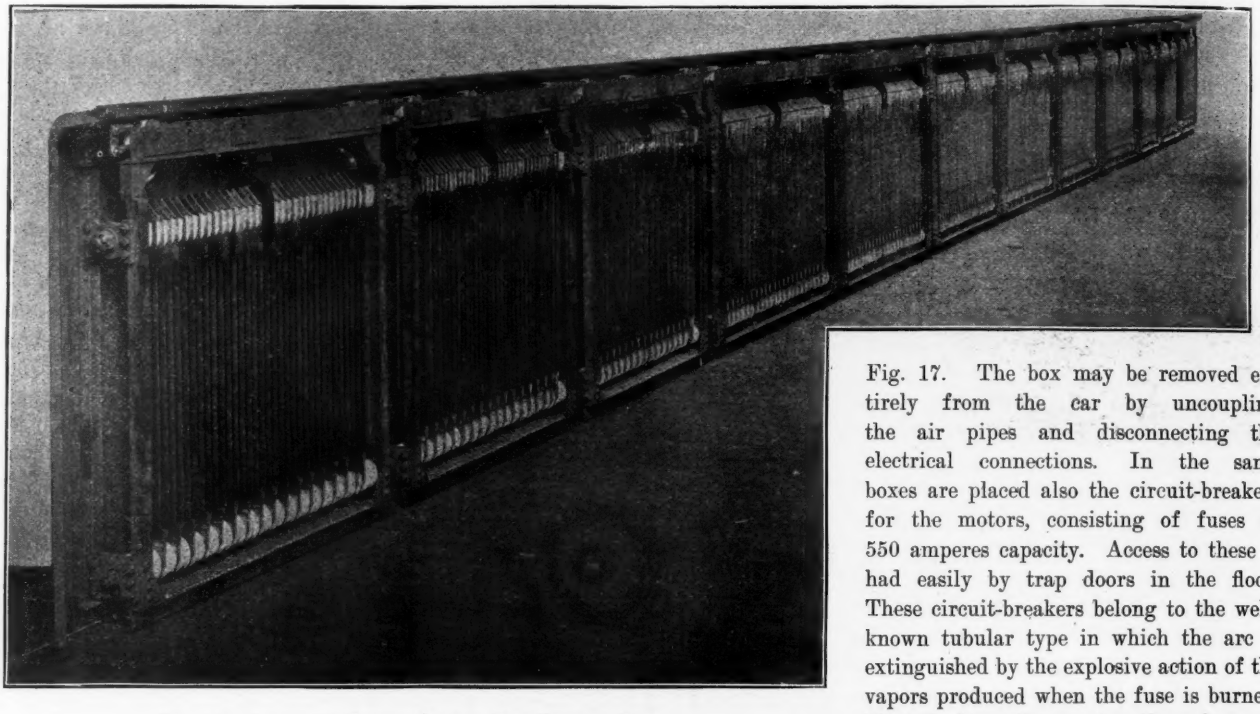


FIG. 14.—GROUP OF RHEOSTATS FOR ONE SIDE OF CAR.

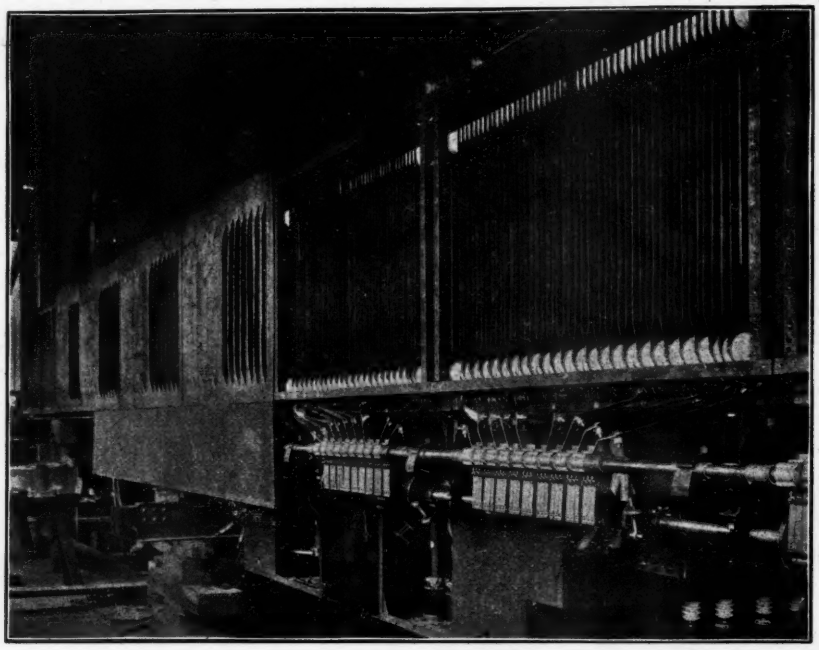


FIG. 15.—ARRANGEMENT OF CONTROLLERS AND RHEOSTATS ON THE SIDE OF THE CAR.

The switches used for connecting the secondary of the transformers in star or delta are constructed in an identical fashion. Each of the two units into which the electrical equipment is divided has four switches for the medium-tension circuit, these being assembled in a box for their protection and the whole placed under the floor of the car. One of these boxes with the lid removed is shown in Fig. 17. The box may be removed entirely from the car by uncoupling the air pipes and disconnecting the electrical connections. In the same boxes are placed also the circuit-breakers for the motors, consisting of fuses of 550 amperes capacity. Access to these is had easily by trap doors in the floor. These circuit-breakers belong to the well-known tubular type in which the arc is extinguished by the explosive action of the vapors produced when the fuse is burned. Fig. 18 shows the construction of one of the fuses. The fixed part is mounted on hard rubber supports, while the removable parts are mounted in a solid glass tube containing the fibre tubes in which the tin fuses are placed.

In these boxes for the medium-tension apparatus are placed also the instrument transformers.

(To be concluded.)

Summer Meeting of the American Institute of Electrical Engineers.

The committee in charge of arrangements for the summer meeting of the

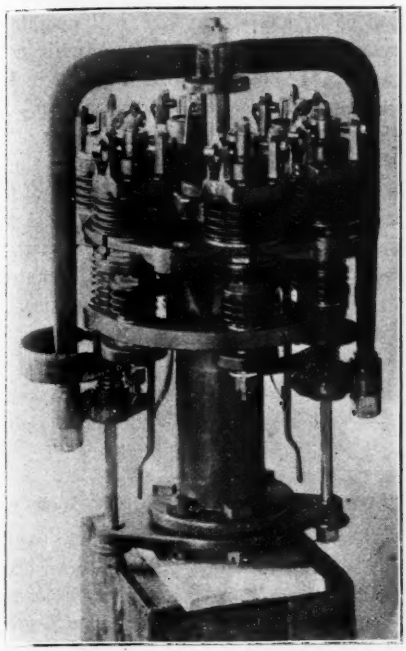


FIG. 16.—HIGH-TENSION SWITCH.

American Institute of Electrical Engineers has decided that the meeting shall be held in Great Barrington, Mass., on June 18, 19, 20 and 21. The Berkshire Inn will be the headquarters, and it is expected later to announce the arrangements made for special rates there and at other hotels in Great Barrington.

A special train will leave the Grand Central Station, of New York city, at 7.30 P. M., June 17 (Tuesday), arriving at Great Barrington about 10.30. The session will be held each day from 9 A. M. until 1 o'clock P. M., the afternoons and evenings being left free. A trip to Pittsfield has been arranged for an afternoon, the fine works of the Stanley Electric Manufacturing Company being the objective point of this visit. Several carriage drives have also been arranged, and a popular lecture will probably be given one evening.

Steam Turbines for South African Mines.

Orders for machinery from South African mining companies have not been as plentiful since the little misunderstanding between John Bull and Oom Paul, but now there are unmistakable signs of renewed interest and activity among the operators and the indications point to an early revival throughout that section. One of the most notable of the late orders reported was placed with Westinghouse, Church, Kerr & Company and called for two 1,000-kilowatt Westinghouse-Parsons turbo-generating sets for the De Beers Consolidated Mines, Limited, for shipment to South Africa.

A DEVICE FOR SYNCHRONIZING MOTORS.

BY WILLIAM DUANE.

In certain kinds of multiplex and printing telegraphs, and in the picture telegraph, it is necessary to have two brushes, type-wheels or drums, at each of two stations, revolving synchronously. The purpose of the device described below is to synchronize two electric motors under the following conditions: Firstly, there shall be but two wires, or one wire and earth return between the two stations. Secondly, this circuit shall be utilized for synchronizing purposes during a small fraction only of the time required for each revolution of the motors. Thirdly, the power transmitted over the line shall be very small compared with the power required to drive the motors. The scheme for synchronizing the motors may be divided into two parts—a regulator for each motor, by which it can be made to run at any desired speed, and by which this speed is kept practically constant; and a device by which, when the motors are running at nearly the same rate, the speed of one or both of them is automatically varied so as to keep them always synchronized with each other.

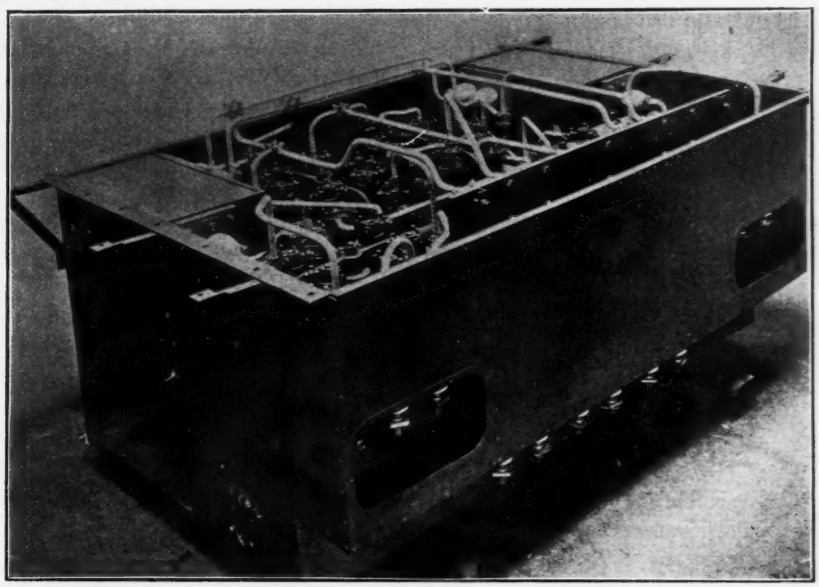


FIG. 17.—BOX CONTAINING INTERMEDIATE PRESSURE SWITCHES.

The regulating device may be understood from the accompanying picture, which is reproduced from a photograph of a machine constructed for experimental purposes. The motor is suspended in such a way that the axis of its armature is vertical. The lower end of the axle is sharpened and rests upon a steel plate just below the flywheel, but not seen in the picture. This is to furnish a firm support and a bearing with very little friction for the rotating parts. The motor's commutator is just above the armature. The axle above the commutator is hollow. Two insulated wires are soldered to two opposite segments of the commutator, and pass up through the hollow axle and out at a hole near the top. The hole is on the far side of the axle and not seen in the picture. One of these wires is carried to the outer left-hand end of the cross-bar (which is non-conducting) and soldered to a nut firmly fastened there. In this nut turns a thumb-screw, which carries a platinum point at its lower end. The other wire is soldered to a metal pin passed horizontally through the cross-bar near the axle. The pin passes through a hole in the upper end of a movable conducting arm, seen in the picture, hanging down near the axle. The arm carries a weight two-thirds of its length from the top, and at its end a small platinum plate. When the armature revolves, owing to the centrifugal force, the arm swings outward, and if a sufficient speed is reached brings the platinum plate into contact with the platinum tip of the thumb-screw. This short-circuits the armature and prevents further increase of speed. If the speed decreases the platinum plate falls away from the thumb-screw and breaks the short-circuit. Thus a speed is maintained which is just about sufficient to bring the plate into contact with the point. The speed of the motor can be varied by screwing the thumb-screw up or down. Two wires similar to those described above are seen in the picture running to a

pin and nut at the other end of the cross-bar, and a second short-circuiting arm could be used on this side, too. This double short-circuit, however, was found to be superfluous. The motor represented in the picture was originally designed as a small series-wound electroplating dynamo. Hence, when running as a motor, the armature revolves in the clockwise direction as seen from above.

The speed of this machine remains constant to within one part in two hundred; further, if stopped, left for a while, and started again on some future day it will run with the same speed as before to within one part in two hundred, *provided no very large change* is made in the electromotive force or resistance of the motor circuit. A large change in either of these quantities, however, will alter the speed slightly. For instance, an increase in the current supplied the motor from 0.8 to 1.4 amperes increases the speed by about two per cent. The fact that this change in speed takes place is due probably to the jarring of the platinum contact. There is very little or no sparking when the contact is broken and it is not necessary to keep the platinum surfaces clean. As a matter of fact, these particular pieces of platinum have not been cleaned since the machine was constructed.

The synchronizing device is as follows: Two motors similar to that represented in the picture are placed at the two stations respectively, and regulated to run at approximately the same speed. The axle of each motor is joined to the line wire by means of a metal rod passed up through the centre of a fixed commutator seen in the picture just below the flywheel. One end of this rod is soldered to the steel bearing-plate upon which the axle rests, and the other is connected by a wire with one of the small binding-posts on the wooden base of the machine and thence to the line. In this line circuit is inserted a battery of sufficient strength to work a high-resistance relay. A metal brush fastened to the flywheel revolves with it and touches in succession the insulated segments of the fixed commutator. Let us call one of the motors A and the other B. One segment of A's fixed commutator is divided into two halves insulated from each other. One-half of the corresponding segment of B's commutator is cut away and the space filled by insulating matter. Let a be the half of the divided segment that A's brush touches first in its revolution, and a' the second half, and let b be the corresponding segment in B's commutator. B is connected directly to the earth or the return wire, and a and a' are connected through two coils of a double relay respectively to the earth or the same return wire. This double relay is so constructed and joined up that a current from a through the coil joined to it pulls a small lever arm over and short-circuits part of the resistance of A's motor circuit, and a current from a' through its coil pulls the same lever arm back again breaking the short-circuit. Suppose that A has been regulated so as to run slightly slower than B. If they are started running, A gradually falls behind B until, when B's brush touches b, A's brush touches a. This completes the circuit through a's coil of the relay, the lever arm is drawn over and the portion of A's motor circuit is short-circuited. A's speed then increases as explained above, and A gradually gains

Electric Motor Synchronizing Device.

on B until, when B's brush touches b, A's brush touches a'. This completes the circuit through a''s coil of the relay, the lever arm is pulled back and the short-circuit broken. A is now running slightly slower than B and the above process is repeated. This keeps the motors running nearly in phase with each other. One motor will gain on the other slightly and then fall behind, but in the case actually tried the difference in phase did not exceed one-fiftieth of a complete revolution.

The advantages of this method of synchronizing motors are that as stated above, a very small current sent over the wire, namely, enough to work a sensitive relay is sufficient to maintain synchronism, and that, since the wires are used for this purpose during a small part of the time only, they may be used for telegraphing almost all the time. Further, if one of the motors is stopped for any reason and started again they will get into synchronism automatically and will run together in only one relative position with regard to each other, *i. e.*, so that when B's brush is on segment b, A's brush is on segments a, a'.

The commutator in the machine represented in the picture was designed for multiplex telegraphy. It has eighteen segments in addition to that used for the synchronizing device. A key placed in a circuit joining any of these segments to the earth or return wire will operate a relay similarly placed in a circuit connecting the corresponding segment in the other machine with the same return. In this way eighteen distinct circuits have been operated simultaneously over a single wire and return running the length of the university campus and containing a resistance of 500 ohms. Only one battery was required to operate these eighteen circuits and the synchronizing device.

Whether the above-described scheme will work over a very long line or not remains still to be investigated.

Hale Physical Laboratory,
University of Colorado.

American Electrochemical Society.

The proposal to form a national society for electrochemists similar in its nature to the American Institute of Electrical Engineers and the American Chemical Society has met with even more encouragement than was at first expected. Over three hundred gentlemen have already expressed their willingness to become members, so that the formation of the society is now assured.

The inaugural meeting will probably be held in Philadelphia, Thursday evening, April 3, and is to be followed on Friday and Saturday by sessions to be held at the electrochemical lecture room of the University of Pennsylvania, at Philadelphia, for the reading of and discussion of papers. Twenty papers have been promised, and a large proportion of prospective members from the eastern and western states will attend. Friday evening will probably be devoted to social intercourse and Saturday afternoon to visits to places of interest to electrochemists.

The detailed programme of the meeting will be duly issued. Mr. Carl Hering, 929 Chestnut street, Philadelphia, is temporary secretary.

Small Engines for Harput.

In a recent letter from Harput, Turkey, Consul Norton writes that a demand is being made there for small, portable steam engines, from one to three horse-power, local industries desiring to replace hand power. Mr. Norton suggests that the entire plant, boiler and engine, be compact and easily portable. Correspondence and price lists will gladly be received at the Consulate, the post office address of which is Mezreh, Mamouret-ul-Aziz, Turkey in Asia.

Electrochemistry and Electrometallurgy.

A Symposium before the American Institute of Electrical Engineers.

(Continued from last week's issue.)

THE ELECTRIC FURNACE IN INDUSTRIAL CHEMISTRY.

BY CHAS. B. JACOBS.

In its early days the electric furnace labored under the burden of the prophecies of its wonderful possibilities and products, and seems to have been more or less associated in the popular mind with the production of diamonds from amorphous carbon, the formation of gems and precious stones from cheap and plentiful materials, and other somewhat sensational operations which had a tendency to obscure, for a time, the knowledge of its usefulness in the field of industrial chemistry.

Notwithstanding the fact that DeChalmot, the Cowles Brothers and others, had been operating the electric furnace for some years in the production of alloys from very refractory ores, it was not until Acheson produced carbide of silicon and Wilson obtained carbide of calcium in commercial quantities, and Moissan published his scientific investigations in *Le Four Electrique*, that the value of the electric furnace for the production of substances useful in the arts began to be generally recognized.

Since that time, however, its field of usefulness has been steadily increasing until it is now obtaining recognition as an important factor in industrial chemistry.

Reference to the patent list of the various countries will show an immense variety of electric furnaces, but they may all be classified under three general types which have been modified in numerous ways to meet the special requirements of the various processes for which they are intended.

The three general types of the electric furnace are:

(1) The reflecting arc furnace of the Moisson type in which the heat of the arc is projected upon the charge by a reflecting surface.

(2) The direct heating arc furnace in which the arc is surrounded by the material treated and imparts its heat directly to the charge.

(3) The incandescent furnace in which either the charge or the walls of the furnace form a part of the electrical circuit and by the resistance offered to the passage of the current produce the required heating effects.

The direct heating arc and the incandescent furnace are the types most frequently met with in commercial work.

The electrical furnace, of whatever type, is, properly speaking, nothing more than a machine capable of producing a high degree of thermal efficiency, for it is not usual in electric furnace work to depend on the current for any electrolytic action; in fact, the alternating current is more regulable and seems to give better heating effects than direct current. When electrolytic action does come into play the furnace reverts to the electrolytic cell of the type in which fused substances are electrolyzed, but even here the effects depend solely on thermic conditions. The compounds formed or decomposed by a given expenditure of electrical energy are directly dependent upon and calculable from the heats of formation of the compounds in question, by virtue of the relationship which exists between the voltage, heat of formation of chemical compounds and their electrochemical equivalents.

The true type of electric furnace is purely thermal in its effects and has no concern with electrolytic action.

The quantity of heat which may be liberated per second in an electric furnace varies from a few hundred calories in small laboratory furnaces to many thousand calories in large furnaces of commercial capacity. The intensity of the heat or the temperature which may be obtained in an electric furnace is limited and controlled by various conditions, chief among which are the refractability and heat conductivity, or rather lack of heat conductivity in the material of which the furnace is constructed.

In furnaces constructed with linings of pure carbon blocks reenforced with some very poor conductor of heat, such as magnesia or chalk blocks, it is possible to obtain a temperature close on to 4,000 centigrade, but at this temperature the purest carbon begins to vaporize.

The temperature to which the charge in the furnace may be raised is, of course, dependent upon the weight and specific heat of the material to be treated, and this data being known the temperature obtainable may be calculated with some degree of exactness, especially when the duration of the heating is short and the charge is enclosed in furnace walls of very low heat conductivity, so that the heat generated is mainly absorbed by the charge.

It is comparatively easy to operate commercially at temperatures ranging from 2,500 to 3,500 degrees centigrade and to raise the charge almost immediately to the required temperature. Operating at these high temperatures, which may be constantly maintained until the desired operation is completed, reactions will take place between elements which have apparently no affinity for each other at the temperatures obtainable in ordinary combustion furnaces.

All are more or less familiar with the results obtained by Moissan in his electric furnaces, and Borchers claims to have gone far toward proving that every known oxide may be reduced by carbon in the electric furnace.

Among some of the most striking of the new chemical compounds of the electric furnace are carbide of silicon, carbide of calcium and the silicides of the alkaline earth metals.

The carbide of silicon, or SiC, or carborundum, as it is commonly called, was discovered by Acheson about 1893. It is the direct combination of two very similar elements and probably has the structure Si$\equiv\!\!=$C, the silicon and carbon being linked together by double bonds. It is only a shade less hard than the diamond and has found a ready market as an abrasive and is being manufactured on a large scale by the Carborundum Company, at Niagara Falls. Very little of practical value has been discovered regarding its chemical properties, although it will undoubtedly be found to have some striking and very useful chemical properties which sooner or later will find commercial application of value.

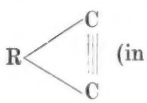
The carbide of calcium, which was first produced commercially by Wilson about 1895, we are all familiar with, chiefly from its use in the production of acetylene gas for illuminating purposes. Its importance as a reagent in manufacturing chem-

istry is, however, becoming recognized, and with the proper investigation of its properties it is only a question of time before its consumption for manufacturing purposes would equal, if not exceed, its present consumption as an illuminant. It is a powerful dehydrating agent and possesses the property of extracting water and even the hydroxyl group from other compounds.

The possibility of using calcium carbide as a means of synthetically producing the valuable constituent of coal tar in a pure state, and the compounds of the benzine series in general, is very inviting; a very pure sample of anthracene, one of the valuable dry products, has been prepared by the Ampere Electro-Chemical Company, using calcium carbide as the original source of the hydrocarbon.

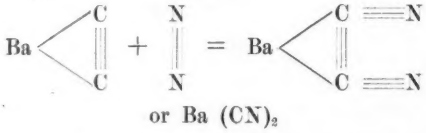
The carbides of the alkaline earth metals in particular offer a fruitful field for original investigation and synthetic work. The fact that they are unsaturated compounds and capable of forming further addition products, under the proper conditions, makes them specially attractive.

All the evidence seems to point to



(in which R represents the alkaline earth metal), as the structural formula for the alkaline earth carbides, but two of the eight bonds of the two carbons being satisfied by the bivalent alkaline earth metal, the other six are satisfied by the affinities between the two carbons for each other, which is not a very strong combination. If now this compound be heated in the presence of some element having a stronger affinity for carbon than carbon has for itself, the bonds between the carbons will open and the new and stronger element will attach itself to the carbons of the carbide to form a saturated compound. Nitrogen, for instance, if passed through heated carbide of barium under the proper conditions will, at a certain critical temperature, combine with the carbide forming a cyanide of the barium.

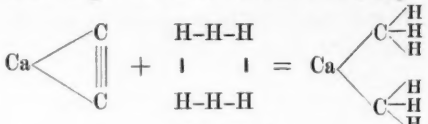
The structural equation probably best explains what takes place:



or Ba $(CN)_2$

The Ampere Electro-Chemical Company has taken advantage of this property of the carbides in the production of the cyanides of sodium and potassium, barium carbide being used as the absorber of nitrogen derived from the atmosphere, and as the carrier of the cyanogen which is subsequently converted by ordinary chemical means into sodium or potassium salt, the barium being used over again in the production of more barium cyanide.

Hydrogen if introduced with heated carbides should combine in the same manner at some critical temperature, forming, for instance, with calcium carbide, what might be called calcium di-methyl.



or Ca $(CH_3)_2$

Any of the unsaturated carbides should act in a similar manner.

The silicides of the alkaline earth metals, namely, calcium, barium and strontium, were discovered by the Ampere Electro-Chemical Company in July, 1899. These compounds which have the formula Ca Si_2, Ba Si_2, and Sr Si_2, respectively, are the silicon analogues of the alkaline earth carbides. The relationship is readily seen when the structural formulæ are compared:

Silicon has replaced the carbon of the carbide, R, remaining the same in both compounds.

These compounds are formed in the electric furnace under conditions similar to those maintained in the manufacture of alkaline earth carbides, although at a somewhat higher temperature, when the carbonates, oxides, sulphates or phosphates of the alkaline earth metals are mixed with silica, in which the relative proportions of the alkaline earth metal to the silicon in the mixture is as one to two, and sufficient carbon to effect the reduction is added, or when silicates of the alkaline earth metals in which the molecular relation of the alkaline earth metal to the silicon is as one to two, are mixed with sufficient carbon to combine with the oxygen of the silicates and heated in the electric furnace. These compounds are white or bluish white substance of metallic appearance, and resemble the silicide of aluminum and metallic silicon somewhat in appearance. They possess a distinctly crystalline structure, showing plate-like crystals on fracture. They oxidize slowly in the air at ordinary temperatures, and more rapidly under the influence of heat, yielding silicon dioxide and the oxide of the alkaline earth metal. Like the carbides they decompose with water, but yield instead of acetylene, hydrogen in a pure state, which is evolved without explosion. The following is the reaction between barium silicide and water:

$$Ba\,Si_2 + 6\,H_2O = Ba\,(OH)_2 + 10\,H$$

Calcium and strontium silicide react in the same manner. The calcium compound decomposes very slowly in cold water, but more rapidly in hot water, barium silicide decomposes rapidly in both hot and cold water, while the strontium compound decomposes more rapidly than calcium but less so than barium silicide.

All of these compounds produce large volumes of hydrogen in a pure state; when chemically pure the following amounts of hydrogen may be obtained from one pound of silicides on treatment with water:

One pound calcium silicide, 18.73 cubic feet of hydrogen,

One pound strontium silicide, 12.36 cubic feet of hydrogen,

One pound barium silicide, 9.15 cubic feet of hydrogen,

at zero degrees centigrade and 760 millimetres.

The silicides decompose rapidly in dilute acids, the barium compound producing silico-methane and free hydrogen according to the following equation:

$$2\,BaSi_2 + 4\,HCL + 6\,H_2O = 2\,Ba\,Cl_2 + 2\,SiH_4 + 4\,H + 2\,SiO_2 + 2\,H\,O.$$

Calcium silicide, strange to say, acts in an entirely different manner when treated with dilute acids and gives rise to the formation of a new chemical compound which has the formula Si_2H_2, the reaction which produces it being as follows:

$$Ca\,Si_2 + 2\,HCL = Ca\,Cl_2 + Si_2H_2.$$

This compound is the silicon analogue of acetylene, C_2H_2, and must therefore be called silico-acetylene, since it bears the same relation to silico-methane, $Si\,H_4$, as acetylene bears to methane, CH_4. It is a yellow crystalline solid and differs in properties from the compound Si_2H_3 which Ogier obtained by sparking silico-methane. The compound of Ogier was unstable and exploded when subjected to a shock. Silico-acetylene is not explosive and is stable at ordinary temperatures. Heated in the air it oxidizes rapidly giving silicon dioxide and water. When heated in a closed tube it breaks down into amorphous silicon and free hydrogen. It is insoluble in acids but when treated with caustic soda and potash solutions it yields hydrogen and a silicate according to the following equation:

$$Si_2\,H_2 + 4\,Na\,OH + 2\,H_2O = 2\,Na_2\,SiO_3 + 10\,H.$$

Strontium silicide is remarkable on

treatment with dilute acids, from the fact that it follows both calcium and barium in its behavior, yielding a mixture of free hydrogen, silico-methane and silico-acetylene.

The practical applications of the alkaline earth silicides and of silico-acetylene are many and varied, although the compounds are of almost too recent origin to have touched on more than a few of the most apparent of their uses. Barium silicide seems to be rather the most important of the silicides on account of its great activity and the positive nature of all its properties. Strontium would answer as well for most purposes, but the scarcity of strontium compounds makes it somewhat more expensive and difficult to obtain in commercial quantities.

As a hydrogen producer barium silicide probably offers the cheapest and most convenient source of pure hydrogen in commercial quantities, it being only necessary to introduce the material into an ordinary acetylene gas generator and add cold water to obtain pure hydrogen.

All of the silicides are strong reducing agents for both organic and inorganic compounds.

Barium silicide has been used for the reduction of indigo and seems to offer many advantages over zinc dust and Schutzenburger's reagent. It is only necessary to make the indigo blue into a thin paste with water and introduce the finely ground silicide; the solution of indigo white thus produced is clean and free from impurities and can be applied directly to the fibre of the cloth or substance to be dyed.

For organic compounds in general when it is of advantage to make reductions in neutral solutions barium silicide serves the purpose admirably.

Silico-acetylene can be substituted for barium silicide as a reducing agent when the reductions are carried out in caustic soda or potash solutions.

The silicides of barium and strontium will undoubtedly find many applications as reducing agents in the analine industry.

One of the large consumers of calcium, as well as barium silicide, will probably be the iron and steel industry. The alkaline earth silicides when melted with iron carrying sulphur and phosphorus have the property of combining with the sulphur and phosphorus, forming sulphides and phosphides of the alkaline earth metal, while the silicon alloys with the iron as silicide of iron. If now the melted mass be blown with air in a steel converter, the sulphides and phosphides of the alkaline earth are oxidized to sulphates and phosphates while the silicon burns to SiO_2 and these impurities rise to the surface as slag, thus freeing the iron or steel of their sulphur and phosphorus. Tests have been made on irons carrying an excess of sulphur and phosphorus in which the last traces of these troublesome impurities were found to have been removed.

The silicides also offer a good field for original investigation. Tucker and Moody, in a paper published in the *Journal of the Society of Chemical Industry*, October, 1901, on the production of ethylene from inorganic sources, show that when a mixture of barium carbide and barium silicide is melted and the mass treated with water, a gas is produced which contains about fifteen per cent by volume of ethylene, and conclude their paper with the statement that it seems possible by the methods they employed to obtain a product which, on treatment with water, simultaneously produces a mixture of ethylene and acetylene. The ethylene is probably produced by the combination of acetylene and hydrogen rendered nascent at the same instant from the carbide and silicide in such close contact as to practically constitute a galvanic couple between the two compounds. This seems to be the most reasonable explanation of the results, since mechanical mixtures of carbide and silicide fail to produce the result.

A practical suggestion offered by the results obtained by Tucker and Moody is that a mixture of acetylene and ethylene might work to very good advantage in gas engines, particularly for automobiles and launches, and the fact that the gas-producing compounds can be stored and conveniently carried in considerable quantity make the suggestion rather attractive.

The electric furnace has to its credit the commercial production of two of the products of nature which are worthy of mention, namely, the production of graphite from amorphous carbon or coal by Acheson, and the production of corundum from amorphous alumina, such as bauxite or other aluminus compounds, invented by the Ampere Electro-Chemical Company and now being operated by the Norton Emery Wheel Company. Both of these processes are in commercial operation at Niagara Falls, N. Y.

The advantage to the consumer of being able to secure manufactured graphite and corundum in unlimited quantity, and of a higher degree of purity than the natural products, at a competitive price, is of inestimable value commercially, especially since the natural sources of both of these products are, as a rule, isolated from the points of consumption and the natural supply becoming somewhat limited.

So much for the electric furnace and its new products and their probable value in industrial chemistry. The electric furnace is, as a rule, only of commercial value, in carrying out processes or producing results that can not be obtained in any other way. The enormous consumption and cost of horse-power required for chemical work and the consumption of carbon electrodes are items of serious expense. There are, however, a number of instances in which it is of advantage to introduce the electric furnace to replace the ordinary means of bringing about chemical reactions that take place at high temperatures, since it not only shortens the time required for the reactions and thus increases the yield for a given time, but the reactions in many cases take place much more completely. It also offers the additional advantage of placing the heat at the point required. The substitution of the electric furnace for the ordinary means of bringing about heat reactions is, as a rule, merely a problem of economic engineering.

Working under the Readman process it has been found advantageous to introduce the electric furnaces in the manufacture of phosphorus; the retorts containing the ordinary mixture of phosphorus-bearing material, silica and carbon are heated from within by an arc and the phosphorus is distilled off and is condensed under water in the usual manner. The chief feature of the process is economy in breakage of apparatus, due to the external heating by the old method; for the same reason electrical heating has been resorted to in the manufacture of carbon bisulphide. However, the more perfect control of the heat has also been a feature in both of these instances.

Another important use of the electric furnace in industrial chemistry is its application in the treatment of substances which are difficult to reduce or which only yield a partial reaction even on long-continued treatment at temperatures obtainable in ordinary combustion furnaces.

The old method of working barytes or barium sulphate consists in treating it with coal or coke in reverberatory or retort furnaces. By this method from sixty-five per cent to seventy-five per cent of the available barium sulphate is converted by reduction into the soluble sulphide of barium, which is then manufactured with other salts of barium.

By a process in operation by the United

Barium Company, at Niagara Falls, N. Y., barytes is treated in the electric furnace, whereby from ninety-seven per cent to ninety-nine per cent of the available barium sulphate is converted into soluble form.

The electrical process was invented and developed by the Ampere Electro-Chemical Company. Its discovery brought to light a new chemical reaction which takes place beyond the range of temperatures attainable in combustion furnaces.

When a mixture of three molecular equivalents of barium sulphate and one molecular equivalent of barium sulphide are introduced into the electric furnace and the mass brought to a state of fusion, a reaction sets in according to the following equation:

$$3BaSO_4 + BaS = 4BaO + 4SO_2.$$

The reaction takes place so completely that not more than two or three per cent of the unconverted sulphate is left in the charge, and taps have frequently been made from the furnace in which the amount of unconverted barium sulphate present was found to be less than one per cent.

The furnace used in the process is a new form of continuous electric furnace of the direct-heating arc type and is tapped periodically, similarly to an iron blast furnace. The product tapped from the furnace is dissolved in hot water and the insoluble impurities filtered off. The filtrate, which consists of a saturated solution of barium hydrate containing a small amount of barium sulphydrate, is cooled and the hydrate crystallized out as $Ba(OH)_2 + 8 H_2O$. The sulphydrate remaining in the other liquors is separated from the crystals of hydrate and carbonated or converted into some of the acid salts of barium.

Barium hydrate is the chief product of the process and on account of its extreme purity and the price at which it is produced by the electrical process has met with a ready sale in fields which have heretofore been closed to it on account of price. The old methods of working barytes do not produce barium hydrate at a price which admits of its large consumption in the arts. The fields into which it is finding its way are the white pigment and dry color trades, the purification of water for industrial purposes, and general manufacturing chemistry. Its largest consumption, however, lies in the beet sugar industry for the purpose of recovering the sugar which remains uncrystallized in the molasses. In addition to the domestic consumption for this purpose some large orders have been booked for foreign consumption. So steadily has the demand for this product increased that after less than a year's operation it has been found necessary to increase the capacity of the plant to a basis of sixty tons of barium hydrate per day.

A further great advantage of the electric furnace is the facility with which operations may be conducted in the presence of various gases so as to bring their chemical actions into play on other substances at a high temperature, or to make them react together, under the influence of the arc. Some rather striking results have been obtained by the use of hydrogen or gases containing a high percentage of it, such as water gas, upon various substances, particularly silicates at the temperature of the electric furnace.

If kaolin or china clay be raised to the temperature of the electric furnace, and hydrogen be passed through the highly heated silicates, the hydrogen combines with the silicon to form silicon hydride according to the following equation:

$$Al\ Si_2O_7 + 8\ H = SiH_4 + 2\ H_{20} + Al_2\ SiO_5.$$

The reaction is progressive and if continued the lower silicate first formed will eventually be reduced to aluminum oxide. Metallic aluminum has even been produced by this reaction by continuing the operation with the aluminum oxide, but owing to the high temperature at which the reaction takes place most of the product is lost by volatilization and the yield of the metal is very small. The lower silicate of aluminum and the oxide formed make very good abrasives with a hardness varying from eight to nine in the scale.

The silicide hydrogen issuing from the furnace ignites spontaneously as it comes in contact with the air producing silicon dioxide and water vapor. This silicon dioxide being the product of the combustion of a gas is in a state of extreme subdivision and makes a polishing agent for silver and fine metal work superior to most of the products in use for that purpose.

Probably no field offers so many important commercial problems for solution as the chemistry of the gaseous elements. The possible synthetic combinations of gases and combinations of the gaseous elements with solids open an almost limitless field for investigation, including as it does the possibility of the synthetic production of bread stuff, starches, gums, carbohydrates and the fertilizers. Undoubtedly the electric furnace and the electrolytic cell will play an important part in the solution of many of these problems. Sir William Crookes pointed out the importance of the atmosphere as a source of nitrogen compounds for the production of fertilizers. Crookes, Lord Rayleigh and others have shown experimentally that chemical combination of the nitrogen and oxygen of the air can be made by means of a disruptive discharge. That their results have remained experimental is largely due to the fact that their conditions lacked one great essential, namely,—energy. The disruptive discharge has little or no energy. To bring about chemical reactions in anything but trivial amounts requires a definite amount of energy. It remains for Mr. Charles S. Bradley to take the initiative in grasping the fallacy of the experimental results, and to introduce the energy necessary to bring about the combination of the oxygen and nitrogen of the atmosphere in commercial quantity. The work carried on jointly by Messrs. Bradley and D. R. Lovejoy, first in New York city and for the past year at Niagara Falls, N. Y., has carried the problem of the fixation of atmospheric nitrogen from the realm of experiment and placed it on a basis of commercial development.

Mention of the process is not out of place in this paper, since in reality the apparatus in which the combination of the nitrogen and oxygen takes place can very properly be classed as an electric furnace of the direct heating arc type, in which the arc imparts its heat directly to the charge, which in this case is dry air.

The Atmospheric Products Company, with which Messrs. Bradley and Lovejoy are connected in this work, depends for the combination of oxygen and nitrogen upon the proper use of a number of extremely high-tension arcs brought into intimate contact with carefully dried air. In addition to the high tension of the arc sufficient current is carried to furnish the necessary energy for raising the molecules of nitrogen and oxygen to their ignition or combining point.

The results so far obtained have demonstrated on a practical scale great economy in the manufacture of nitric acid and the nitrates, also nitrous acid and the nitrites, which make possible the cheap production of all of the commercial products which can be chemically derived from these compounds.

Of the value of the electric furnace in purely scientific investigations little need be said. As some one has already pointed out, in the formation of the metallic carbides and their subsequent decomposition, the electric furnace has offered a very plausible explanation of the occurrence of

our natural gas, petroleums and bitumens, while the formation of graphite and corundum has thrown still further light on some of the phenomena and products of the various geological ages.

COLLOIDS.

BY W. R. WHITNEY.

The purpose of this paper is to bring before the Institute the present condition of investigations in a field which, while it is perhaps primarily of chemical interest, promises to be also of physical, electrochemical and biological interest. It deals with the class of substances known as colloids. The name is due to Graham, who first recognized in gelatinous solutions such as silicic acid, etc., certain characteristic properties.

It is a well-recognized fact that when two different substances are brought into contact they assume what we call equal and opposite electrostatic charges. This seems to be the case no matter of what the two different substances consist, and is apparently true in case of the solid, liquid or gaseous state. The familiar experiment of rubbing glass or sealing wax with silk, wool or fur is an illustration of this fact, and the action of the various static electric machines depends upon it. The interesting application of the principle in the case of electrostatic differences produced by metals in contact is still a ground for such speculation, and it seems that only in the case of metals which are in contact with solutions, or of different solutions in contact with one another, our knowledge is very far advanced. It should be mentioned, however, that measurements of potential differences between solutions and gases have also been made. We may accept, then, as a postulate, that a physical surface or boundary between dissimilar substances is always the seat of a potential difference.

If a mass of insoluble matter, as quartz, sulphur, turpentine, or even gas bubbles, be suspended in water, the former becomes usually negatively charged, the latter positively. If this material be finely divided by any mechanical process, as by grinding, no reason appears why it should lose its property of being thus charged, and we are immediately brought to consider a condition which probably exists very commonly in nature, though it has not been generally recognized as such. This has been called the colloidal condition, and it is a condition whose characteristics may be due to these charges, or, more likely, due to the same causes as are these charges. If the particles of quartz or other material were sufficiently minute it is probable that the repellant force acting between them (they being all of the same sign) would keep them apart and thus also tend to prevent their settling in water. How this might be finally attained as the particles were reduced in size may be seen when it is considered that their weight would diminish in proportion to the reduction of their volume, while the charge would be constant in potential, but increase with the surface exposed, and, for a given weight, a relatively greater surface is being exposed as the particles are further reduced in size. So that the smaller the particles the greater the influence of the charges.

On the basis of this consideration we ought not to be surprised to find suspensions in water of insoluble matter which never deposit by the action of gravity alone. Finely divided platinum, gold and other difficultly oxidizable metals may be brought into suspension in various ways in pure water, and these suspensions are practically permanent. Sulphur, selenium, silicic acid, the insoluble hydrates and sulphides of metals, etc., may be similarly made to assume a stable state of suspension. In short, a careful consideration of the ways in which suspensions are actually made force one to the conclusion that whenever any substance which is by nature insoluble in water is produced in the water in a very fine state of division, a permanent suspension or so-called colloidal solution will result if electrodes be absent. This fine state of subdivision should exist (as it probably does) in all cases where the insoluble substance is produced chemically *in situ,* for it is produced molecule by molecule. It should also exist where vapors condense in the water, as occurs with subaqueous electric arcs between metal electrodes.

The question naturally arises at this point why then are such suspensions not identical with solutions? This has been the subject of much study and experiment, and it seems now that we are justified in distinguishing between solutions proper and the so-called colloidal solutions (or, more correctly, suspensions) by the following characteristics:

A saturated solution, at any temperature, may be made by bringing the solvent and substance to be dissolved into contact, whereby the process of solution usually commences immediately and proceeds to saturation with a velocity dependent upon the surface of substance exposed. This velocity varies at any instant inversely as the degree of saturation then reached. Suspensions or colloidal solutions, on the other hand, are not made in this way. For example, a mass of sulphur brought into contact with water never produces a colloidal sulphur solution.

Again, in a solution proper, the presence of the dissolved substance produces certain effects called osmotic, which are not produced in the case of suspensions. For example, the solution of any non-volatile substance in water will cause a certain rise in the boiling point of the water and the water will also no longer freeze at thirty-two degrees Fahrenheit, but at a certain lower temperature. This is not the case with the colloidal solutions, for here the presence of the suspended matter is of little or no influence upon the properties of the water. The tendency of the material of suspensions to diffuse in the liquid is very slight or almost absent, while diffusion of material in ordinary solutions is marked, and its tendency or diffusive force, as measured by the osmotic pressure, is very great.

Another difference must be mentioned and it is this which is of the most interest from the electrochemical or electrical standpoint. Suspensions are usually completely coagulated or precipitated by the presence of small quantities of electrolytes, and this does not occur with solutions. A suspension of platinum in exceedingly pure water is a black liquid, transparent in thin sections and perfectly stable. The slightest dissolved impurity in most cases will cause its precipitation, if that impurity be an electrolyte, as a salt. Non-electrolytes, as sugar, are without this effect. The quantitative relations which exist between the amount of platinum thus precipitated or coagulated and the electrolyte precipitating it are such that a simple chemical reaction seems out of the question. The impurities in ordinary distilled water are usually great enough to precipitate this colloid in a few hours and, therefore, the permanent suspension can be made only with the greatest care. It is also true, if not in all, at least in most cases, that the colloidal solution or suspension shows its lack of homogeneity in its action on a ray of light. The ray is scattered by the suspended particles and becomes visible in its path through the liquid, the reflected ray being polarized.

It seems probable that through investigations of the properties of the simple inorganic colloids, as for example pure metal suspensions, sulphides or oxides, we may learn something about the heretofore little understood colloids of nature. The importance of this point is seen when it is recognized that most of the reactions of plant and animal growth and life involve colloidal solutions, such as starch, protein matter, ferments, etc.

We have then, two kinds of solutions. First, the real solution, such as filterable, transparent, homogeneous mixtures of acids, bases, salts, sugar, alcohol, etc., with water, where common, well recognized laws govern the properties, and second, the colloidal solution or suspension which is also filterable and transparent, but does not show many other properties characteristic of the real solution. In this latter class are probably most of the reagents used in the mysterious reactions of living organisms.

Among the first class are all the mixtures which conduct the electric current and those of sugar, glycerine, etc., which do not, while in the second class there are no electrical conductors. When, however, a pair of charged electrodes are placed in a pure aqueous suspension, or colloidal solution, the colloidal material very slowly moves from the vicinity of the one electrode to the other—some of the colloids moving with, and some against, the positive current. This fact evidently involves a slight conduction, although I have called these bodies non-conductors because this conduction has never been measured and is doubtless very slight. This motion of the colloidal material is another point of evidence favoring the hypothesis of electrostatic charges on the particles, although the simpler assumption of a polarized form of energy is more exact.

Recent work of Coehn and others makes it seem probable that of any two substances in contact, the one with the higher dielectric constant will be positive toward the other.

The theory of electrolytic dissociation is doubtless more or less familiar to most of you, but it is necessary to consider it a moment in connection with this subject.

Experiments show that in most simple aqueous salt solutions a part of the salt is dissociated. The various properties of those solutions which depend on the relative number of particles or molecules present, such as the boiling point, freezing point, etc., are more pronounced than to be expected from the possible number of whole molecules present. It is also only in the case of these dissociated substances that electrical conductivity through the solution is possible. Moreover, in dilute solutions the degree of this conductivity corresponds to the degree of dissociation as measured by the physical effects referred to. The electro-motive force produced by contact of differently concentrated solutions of the same electrolyte may be successfully calculated on the basis of this assumed dissociation and the imagined condition of dissociation seems most probable. The work of Arrhenius, Nernst and others has led to fairly general acceptance of their hypotheses that these dissociated particles are electrostatically charged, and under such an assumption many of the characteristics of these dissociated solutions might be expected. I do not wish to discuss this theory, but to call attention to the fact that it is this class of dissociated substances which for some reason exert the most remarkable influence on our colloids or suspensions. The facts will stand alone without the theory and will remain facts, no matter what is the future history of the theory.

A considerable quantity of a non-electrolyte may usually be added to a suspension or colloidal solution without producing any visible effect, while little more than a trace of an electrolyte is often fatal to the stability of such a suspension. Most if not all colloidal solutions are thus coagulable by electrolytes.

It has long been known that the cloudy waters often obtained from stamp mills in mining operations and which carry valuable metal, can be made to settle by the addition of various salts. Lime is usually used for this purpose. It has also been recognized that the silt suspended in a river's water, as our Mississippi, is caused to settle at the deltas, but not by reduction in current but by the presence of salts from the ocean. This silt can be precipitated in a bottle by simply adding a little salt solution. Suspensions or colloidal solutions of metals like silver, gold and platinum are readily precipitated by such small quantities of salts, or of electrolytes in general, that a simple chemical reaction is practically out of the question. Many of the dye stuffs give solutions which act exactly in the same manner. A number of other organic products of the laboratory have this property, and it is also the property of such suspensions as the insoluble metallic sulphides and oxides; of suspensions made by adding alcoholic solutions of gums or resins to water, or by heating to boiling a dilute solution of egg albumen. These are all cases of electrolytic coagulation or precipitation and seem to be representative types of a large class of processes which occur not only in the chemist's but also in the world's laboratory.

The laws which are being found to exist in the case of these simple suspensions must sooner or later be applied to those cases in Nature where colloidal solutions are undergoing coagulation. It is not absurd to seek their applicability in the case of deposition of starch in the growing plant, of bone and muscle in the maturing animal, etc., for these may well be deposited from colloidal solutions by the same actions.

(To be continued.)

A Mexican Water-Power Development.

A new company, consisting mostly of New York men, has just completed its plans and secured from the Mexican Government an important and valuable water-power concession and franchise for furnishing electric light and power in Toluca, the capitol of the state of Mexico, and the neighboring towns.

The Rossiter-MacGovern Company, of New York city, which has successfully financed and built several electric power plants in this country, secured this concession and has charge of the erection of the plant. The concession consists of two separate water powers, aggregating over 8,000 horse-power. Construction was begun on the smaller plant and the work inaugurated with considerable ceremony by Governor Vincente Villada, of the state of Mexico, in person, on January 2 of this year.

The high price of oil in this locality has made the people very anxious to secure electric lights, and the interest in it was evidenced by the presence of the Governor in person, accompanied by several officials of the state.

The plant will have a nominal capacity of 1,200 horse-power, and contracts have already been made for the furnishing of power and light equal to two-thirds of the capacity of the plant. The installation was designed by Mr. Alex. Potter, electrical engineer of New York, who is in direct charge of construction. The plans have been approved by Mr. W. A. Brackenridge, of the Niagara Power Company.

Counsel for the company is Mr. Henry W. Goodrich, of New York city, and its Mexican counsel is Señor Pablo Martinez del Rio, one of the best known corporation lawyers in Mexico.

Contracts have been let for all the machinery required, and it is expected to have the plant in operation in July next. The Pelton Water-Wheel Company is to furnish three 450-horse-power turbine wheels, together with the steel flume, receiver, etc. The Stanley Electric Manufacturing Company has the contract for three 325-kilowatt generators and the transforming apparatus and switchboard in the station. The General Electric Company will furnish all substation apparatus, rotary converters, transformers and the switchboard, together with some 300 of the newest type 1,200-candle-power arc lamps. The Western Electric Company is furnishing some 200 miles of copper wire and all line material, insulators, etc., together with a complete telephone outfit.

The transmission lines will carry 22,000

volts, at which voltage the power will be transmitted to Toluca which is about twenty-two miles from the main station. Power and light will also be furnished to the municipalities of Tenancingo and Tenango, catering altogether to a population of over 100,000. The water of the stream for which power is depended on has its origin in the rain and snow from Toluca Mountain and is practically constant during the year. Measurements and gauging, which have been in progress since 1895, show a flow of 650 litres or 23 cubic feet per second and a fall of 720 feet in 6,000 feet.

INAUGURATING THE WORK ON THE POWER-HOUSE.

SAN SIMONITI FALLS.

The necessary capital required has been furnished by a syndicate, and upon completion of the plant it will be turned over to the Toluca Electric Light and Power Company, a corporation to be formed under the laws of the state of New York. The principal owners include: Senator Chauncey M. Depew, Messrs. W. W. Goodrich, H. C. M. Ingraham, E. V. W. Rossiter, D. H. Valentine, J. L. Greatsinger, T. S. Williams, C. L. Rossiter, H. C. DuVal, John R. Christie.

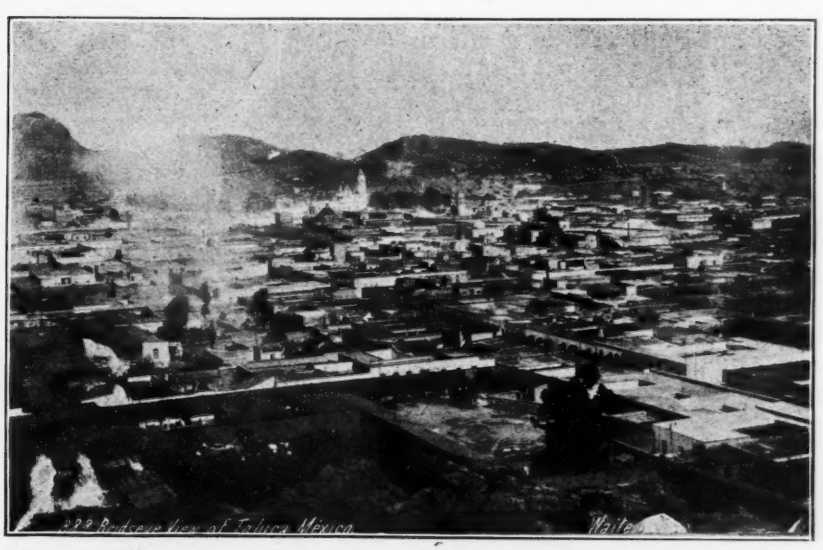
In Bavaria the lime residuum left from the carbide used in producing acetylene gas for car lighting is pressed into cakes and used in purifying feed-water for locomotives. In Munich, nearly three tons of residuum are left daily.

A Gas-Engine Plant in Monterey.

Consul-General Hanna reports from Monterey, Mexico, that he has been informed that James Meehan & Sons, an American firm with several iron plants in the United States and one at Monterey, have decided to establish there a plant for the manufacturing of gas engines. The capital to be invested will be $250,000, Mexican (about $113,000 gold). Gas engines are becoming very popular in Mexico and many are in use. The firm expects to manufacture all sizes and various designs.

LOCATION OF THE POWER-HOUSE.

The largest induction coil, which produces the longest spark for service in wireless telegraphy, is said to be the one made for flashing messages between the coast of Japan and Korea.



A BIRD'S-EYE VIEW OF TOLUCA, MEXICO.

Book Reviews.

"Wireless Telegraphy: A Popular Explanation." G. W. de Tunzelmann, London. Published by *Knowledge*. Cloth. 104 pages. 4½ by 7 inches. 30 illustrations. Supplied by the ELECTRICAL REVIEW at $1.00.

An excellent little book for those who wish to know something of this interesting subject. It might have been shorter and simpler without disadvantage.

"Velocity Diagrams: Their Construction and Their Uses." Charles W. MacCord, New York. John Wiley & Sons. Cloth. 116 pages. 5¼ by 8½ inches. 83 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

Consisting of an abstract of a series of lectures delivered at the Stevens Institute of Technology, this excellent book explains the principle of the more common and convenient graphical processes for determining at any given instant the direction and velocity of the motion of a point. While intended for use in the classroom the book is so arranged as to be valuable to those who desire to study the subject without an instructor.

"Primary Batteries: Their Theory, Construction and Use." W. R. Cooper, London. *The Electrician* Printing and Publishing Company, Limited. Cloth. 324 pages. 5¼ by 8¼ inches. 131 illustrations. Supplied by the ELECTRICAL REVIEW at $2.50.

The author has attempted in this work to give a description both of the batteries which are in general use, and those which contain some element of practical or theoretical interest. Standard cells are dealt with at some length and a chapter is devoted to carbon-consuming cells. The book is a compendium of information on the subject and may be regarded as the last word that has been said upon this rather important branch of electrical work. The typography of future editions might be made clearer with advantage.

"Practical Calculation of Dynamo-Electric Machines." Alfred E. Wiener, New York. *The Electrical World and Engineer*. Cloth. 727 pages. 6 by 9 inches. 381 illustrations. Supplied by the ELECTRICAL REVIEW at $3.00.

This is the second edition, revised and enlarged, of Mr. Wiener's excellent book. While many readers may be found to disagree with the methods employed, no one can find fault with the excellence and volume of the data given. Indeed, in this respect Mr. Wiener's book probably surpasses any similar publication that has yet appeared. The types of dynamos treated range through a very large number of both American and foreign varieties, comprising practically all classes of machines now in use. In the second edition the new matter comprises sections on the calculation of multipolar and multiple-circuit dynamos, double-revolving motors, double-armature motors, etc. The book is excellent in typographical appearance and binding.

"Compressed Air and Its Application." G. G. Hiscox, New York. Norman W. Henley & Company. Cloth. 822 pages. 6 by 9¼ inches. 545 illustrations. Furnished by the ELECTRICAL REVIEW at $5.00.

The author has succeeded in adding to the literature of this subject the first really complete handbook which has yet appeared. The commercial uses of compressed air in the mechanical arts are numerous and important, but, notwithstanding this fact, few subjects in mechanics have been so difficult to find accurate data upon and so little supplied with literature of permanent value. This excellent work unites in a very attractive shape a great body of information pertaining to all of the applications of compressed air, and, while, as might be expected, the case for compressed air as a motive power is given from a somewhat *ex parte* standpoint, the work is one of sufficient value to fill a place of considerable importance. An attractive typographical make-up adds greatly to the volume.

"Elementary Electricity and Magnetism, and Their Applications." D. C. Jackson and J. P. Jackson, New York. The Macmillan Company. Cloth. 482 pages. 5 by 7½ inches. 358 illustrations. Supplied by the ELECTRICAL REVIEW at $1.40.

Here, at last, is a book that has been long awaited. While written as a textbook for manual training schools and high schools and as a manual for artisans, it is so prepared as to be useful for any intelligent reader who wishes to get a good conception of electrical actions and apparatus. In the past elementary textbooks on electricity have generally been unfit for the general reader, and even those addressed directly at the general reader have most often failed in comprehensiveness, in clearness and on account of the assumption, too frequently made, that the general reader is a fool. The authors of this excellent work have aimed at enlisting the interest and appreciation of intelligent people and have succeeded in producing one of the most valuable and interesting books of its character that has yet appeared.

"Elements of Physical Chemistry." Harry C. Jones, New York. The Macmillan Company. Cloth. 565 pages. 5¼ by 8½ inches. 67 illustrations. Supplied by the ELECTRICAL REVIEW at $4.00.

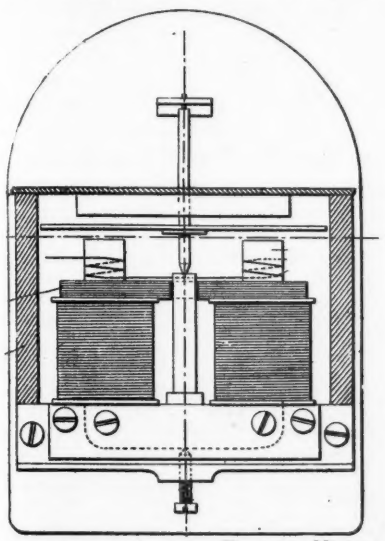
This is the first thorough and complete treatise on physical chemistry that has appeared in the English language. Professor Jones is already well known in the scientific world by his excellent writings on the subject. In this larger and more pretentious work he has undertaken to give a general discussion of the entire subject of physical chemistry, according to the most recent views upon that important branch of science. It is beginning to be recognized that some of the most important developments to be expected along general scientific lines is in the evolution of this exceedingly vital subject. The interrelations of chemistry and physics have become closer as investigation has proceeded in each of these sciences, and today the growing importance of electrochemistry is largely due to the work of early investigators who first recognized the important interconnection of these subjects. Professor Jones has rendered no small service to American science in presenting this excellent work. His style combines great elegance of diction with unusual clearness and simplicity of expression so that while the present work is by no means intended for beginners it possesses almost fascinating interest for those familiar with the principles of chemistry, physics and electrodynamics.

"The Engineering Index." Vol. III. Edited by H. H. Suplee, New York and London. *The Engineering Magazine*. Cloth. 1,030 pages and a frontispiece. 6 by 9 inches. Furnished by the ELECTRICAL REVIEW at $10.00.

The Engineering Index was originated in 1884 by Professor J. B. Johnson, and was first published in the *Journal of the Association of Engineering Societies*. After eleven years of publication in this journal the Index was made a feature of the *Engineering Magazine*, since which time it has been continued with a constantly increasing scope. In its preparation about 200 technical journals of all classes and representing all nationalities are now read and indexed. As an illustration of the growth of the work it may be stated that volume ii of its republication contained about 6,000 entries taken from sixty-two journals, while the present volume contains 40,000 entries taken from 200 journals and covering the period from 1896 to 1900 inclusive. The method of indexing adopted is simple and highly satisfactory and such as to make the volume actually what it purports to be—an index of engineering literature. In each case articles referred to are given by title, together with their source of origin, length and the number of illustrations contained in them. The work is of immense value to those seeking information concerning the literature of any given subject. The typographical arrangement of the book is excellent and reflects credit upon both editor and publishers. The work as it stands is monumental for the colossal labor employed in its preparation, and is certain to find its place in all engineering libraries that desire a ready and easily accessible key to their contents.

Electrical Patents

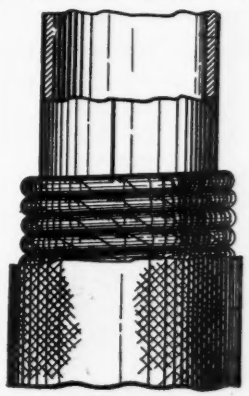
M. Emile Batault, residing in Geneva, Switzerland, has been busy devising a novel form of alternating-current meter, and has obtained several patents in this country upon the same. The invention employs as its primary idea a register actuated by a rotating body or armature which is effected by the resultant field produced by two magnetic fields differing in phase, one of these fields being due to and varying with the current in the work



ALTERNATING-CURRENT ELECTRIC METER.

circuit, and the other field being due to and varying with the electric pressure. In a patent granted in 1900, there is set forth a meter of this type using a disc armature rotating in a plane closely adjacent to two magnetic poles each carrying a shunt coil, and one or both of said poles being provided with one or two series coils for inducing in the armature magnetic fields differing in phase and eccentric to the fields induced by the shunt coils to thereby effect rotation of the armature. The Foucault currents thus induced in the armature produce a checking or braking effect, which in the measurement of currents of substantially constant electromotive force can alone be relied upon to oppose registration. When, however, the electro-motive force is subject to variation the inventor makes use of a separate permanent magnet to secure a constant checking or braking effect which shall be independent of any variation in the voltage. When such permanent magnet is used for the purpose mentioned, it will be evident that the checking or braking effect imposed upon the armature will be due to two factors—namely, the magnetic retardation imposed by the permanent magnet and the generation of Foucault currents by induction—and since, as stated, the latter factor is a variable one, changing with changes in voltage, a corresponding error in the registration will result, and the meter will register disproportionately greater or fewer watts as the voltage falls or rises. In order that this error may be practically minimized, the inventor has recently devised another improvement for which he has obtained another patent. He has found it necessary, in the construction of a meter for the purpose indicated, to depend upon the permanent magnet for the greater bulk of the braking effect. If, for example, fifty per cent of the braking or checking effect is due to the permanent magnet and fifty per cent to the inductive effect of the coils a variation of fifty per cent in the latter effect would result in an error of twenty-five per cent in the total checking or braking action, but if ninety per cent of the braking or checking effect is due to the permanent magnet and ten per cent to the effect of induction a similar variation in the latter effect will result only in a variation of five per cent in the entire braking or checking action. In order to secure this result he employs between the two branches of the shunt magnet a magnetic bridge or diverter made, for example, of laminated iron, and by means of which will be secured a partial closing of the magnetic lines of force below the armature so as to diminish in consequence the number of magnetic lines of force which affect the armature. This magnetic bridge or diverter is placed between the shunt coils and the revolving armature and preferably below the series coils, so that the action of the magnetic field in the armature produced by the latter coils will not be weakened, but will be rather strengthened. It is also possible to so arrange the magnetic diverter that it will perform the additional function of the closed short-circuit windings referred to in the first patent and by means of which the error above noted is overcome when the instrument is used on highly inductive circuits.

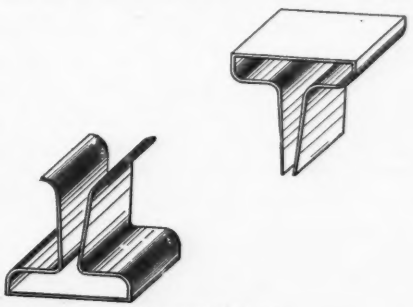
A novel water-proof and fireproof conduit for electric wires has just been patented by Messrs. Edward D. and Horace N. Speer, of New York city. In the preferred form they provide an inner tube formed of any suitable material such as paper or muslin, the meeting edges of which are overlapped and cemented together. Before forming the tube, the material is thoroughly saturated with a fireproofing solution composed of phosphate of ammonia dissolved in water. After saturation the material is dried and formed into the tube and is covered with a coat of water-proof composition composed of eighty parts of refined asphalt and 100 parts of candle pitch, the candle pitch being melted and the asphalt mixed therein. These proportions may, of course, be varied as desired. While this



CONDUIT FOR ELECTRIC WIRES.

water-proof coat is still soft and sticky, a cord of cotton, hemp, or the like, is wound tightly and spirally from end to end of the tube, said cord having first been thoroughly saturated with fireproofing solution and dried. As a result, the cord will embed itself in the water-proof coat and be secured thereby when the coat dries. Over the whole is braided a suitable cover, the yarn of which is also made of fireproof, and finally a coat of water-proof paint is applied to the cover. This conduit, besides being fire and water-proof, also has great flexibility, and the inventors claim that it can be manufactured more cheaply than any other now on the market.

Another improvement has been made in the construction of knife switches. The base or socket piece is of substantially the usual construction comprising a sheet metal strip provided with divergently disposed jaws having out-turned terminals. The invention resides particularly in the construction of the knife or portion arranged to engage between the jaws. This is also made of sheet metal having a loop arranged to surround the knife bar, the terminals or contact blades being arranged



ELECTRIC SWITCH.

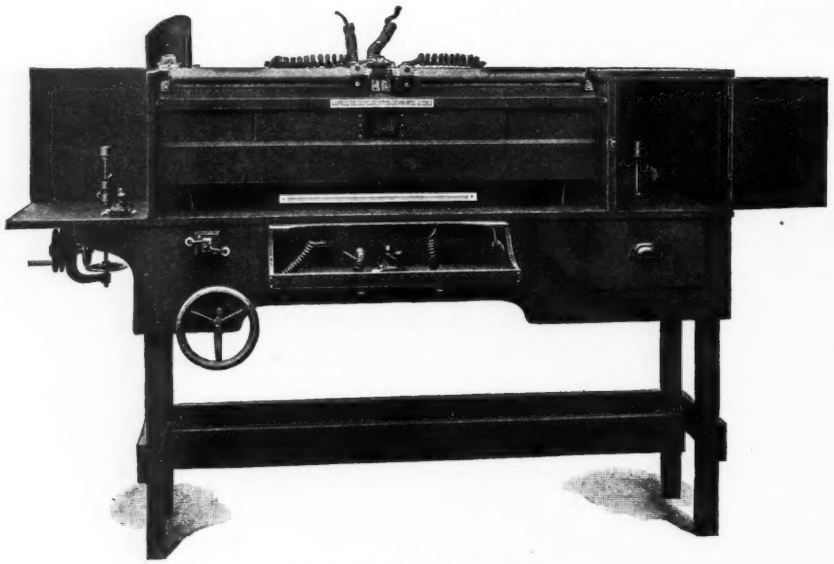
in convergent relation and spaced a slight distance apart, these blades being adapted to fit between the jaws of the socket piece. The construction is very simple and inexpensive, and besides, will adapt itself to the socket, should either element become bent or distorted. The inventor of this device is Mr. Thomas H. Brady, of New Britain, Ct.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

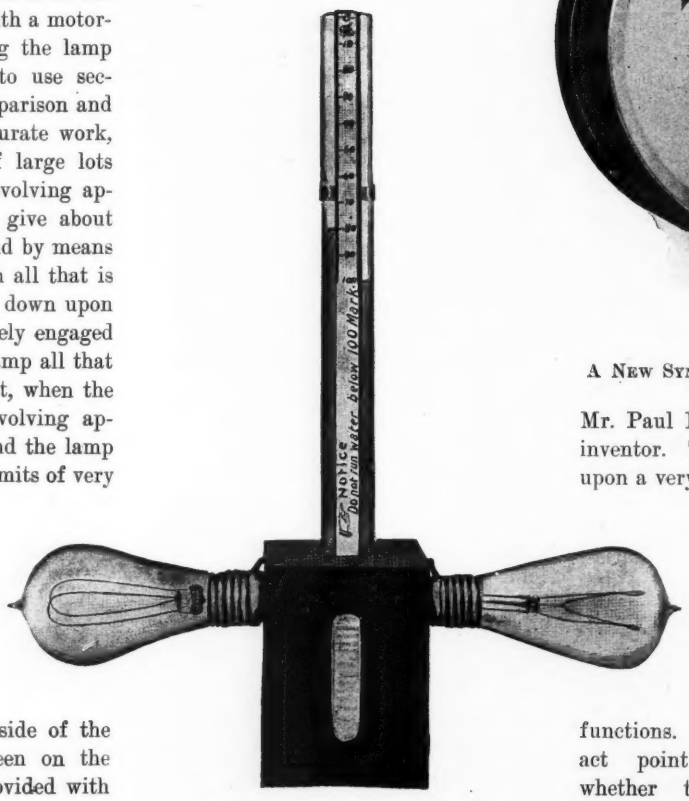
Photometers and Comparimeters.

The accompanying illustrations represent two interesting instruments manufactured by the Bryan-Marsh Company,



A NEW FORM OF PHOTOMETER.

of New York. The photometer is of the Bunsen pattern and is fitted with a motor-driven apparatus for revolving the lamp under test. It is arranged to use secondary lamp standards in comparison and is designed for quick and accurate work, particularly in the testing of large lots of lamps by stations. The revolving apparatus is so arranged as to give about 180 revolutions per minute, and by means of an ingenious friction clutch all that is necessary is to press the lamp down upon its socket when it is immediately engaged and lighted. To remove the lamp all that is necessary is to pull up on it, when the reverse mechanism of the revolving apparatus is thrown into play and the lamp is rapidly unscrewed. This admits of very quick handling and saves much loss of time in adjusting the lamps under test. The photometer is fitted with a Bunsen screen of great delicacy, a hand-wheel being provided at the lower left-hand side of the machine for moving the screen on the scale. Each photometer is provided with a complete set of checking and working standards, consisting of lamps. They are also fitted with resistance sliders, whose temperature coefficients are negligible. The comparimeter is an arrangement intended to give rapid and very accurate comparative tests of lamps of the same candle-power and voltage. The instrument works on the well-known principle of the gas voltameter. Upon the passage of the current gases are liberated in each of the two vertical tubes of the machine, and when that having the lowest level reaches 100 on the scale current is shut off. The percentage consumption of current of the other lamp is immediately given by reading the scale. About thirty seconds are required for this test, which is also claimed to be very accurate.



ELECTRIC LAMP COMPARIMETER.

A New Synchronism Indicator.

The accompanying illustration represents a synchronizing machine made by

A NEW SYNCHRONISM INDICATOR APPARATUS.

Mr. Paul M. Lincoln, Niagara Falls, its inventor. This instrument is constructed upon a very ingenious and beautiful principle, set forth by Mr. Lincoln in his paper read before the American Institute of Electrical Engineers at the Buffalo convention last summer. It performs simultaneously three functions. It shows, first, the exact point of synchronism; second, whether the incoming alternator is running too fast or too slow, and third,

how much too fast or too slow it is running. The machine is made amply large, the diameter of the dial being twelve inches so that it may easily be seen by both switchboard attendant and the man regulating the speed of the engine or water-wheel. The non-inductive resistance in series with one of the armature circuits of the machine consists of an incandescent lamp which, being mounted behind the translucent dial of the apparatus, makes it readily readable at night. The instrument is made for 110 volts standard and for the various standard frequencies. The instrument is capable of very rapid and accurate work. For example, five of the 5,000-horse-power alternators of the Niagara Falls Power Company have been paralleled successfully in three minutes by its use, whereas, with the synchronizing lamps formerly in use, twenty minutes would have been considered rapid work.

Electric Light Blue-Printing Apparatus.

The accompanying illustrations exhibit an interesting and efficient machine for

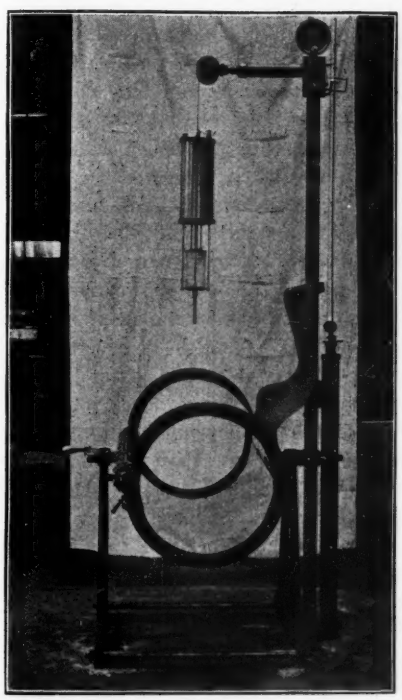


FIG. 1.—ELECTRIC BLUE-PRINTING APPARATUS—PUTTING ON THE PAPER.

making blue-prints or photographic prints of any kind indoors, either by day or by night. The apparatus may very readily be understood from the accompanying engravings. It consists essentially of a cylinder of glass mounted in a frame on trunnions and capable of being locked in either a vertical or horizontal position. An arc lamp of the enclosed type is suspended from a standard centrally over the axis of the glass cylinder. The lamp is swung from a cord running over a system of pulleys to a piston working in a long vertical cylinder which is supplied with a valve. The lamp being heavier than the piston tends to descend, and its rate of motion may be governed very accurately by setting the valve. In this way the lamp may be made to require from five seconds to twenty minutes in traveling through the cylinder. This regulation is, of course, made with reference to the sensitiveness of the blue-print paper used. When the lamp has reached its maximum downward position, the supply of current is automatically cut off, the cutout being held in this position until the lamp is returned to its normal position above the cylinder.

The method of using the machine is very simple; the glass cylinder is put in

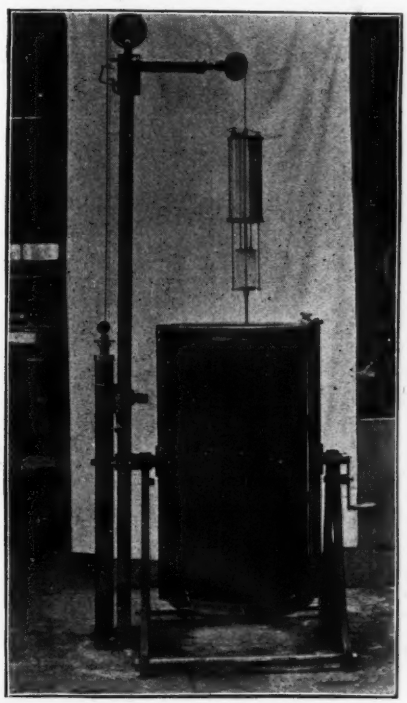


FIG. 2.—ELECTRIC BLUE-PRINTING APPARATUS—READY TO BEGIN PRINTING.

horizontal position, the tracing and sensitized paper being placed on the outside of it and covered by the canvas belt which surrounds it. This can be drawn taut by a roller handle provided for that purpose. The cylinder is then turned up to a vertical position, the lamp is brought down to the level of its top and the current is turned on. The lamp slowly descends through the cylinder, the time having been determined by the quality of blue paper used, and is automatically extinguished when it reaches the bottom of its course. All that is necessary then to do is to wind up the lamp by means of the windlass, take off the blue paper and start over again. The apparatus is made by the Elliott Electric Blue Print Company, of Pittsburgh, Pa., and is already in use in a number of manufacturing establishments.

Telephone Pay Station.

Among the many devices which have been produced from time to time to increase the use of the telephone among those subscribers who have not enough business to use an individual apparatus, the pay-station idea has been given considerable attention.

The Chicago Pay Station Co., Chicago, Ill., manufactures a pay-station apparatus

AUTOMATIC PAY STATION APPARATUS.

illustrated in these columns. This is claimed to be a strictly high-grade machine and is giving complete satisfaction to the telephone companies which have used it. It can be fitted to any style telephone and operated over any line. It is entirely mechanical and simple in operation. The signals are strong and distinctly transmitted. Where more than one slot is used, a rejector device throws out any coin which may be deposited in the wrong slot by mistake or otherwise.

The case is in one piece and the money drawer fitted flush, allowing no opportunity for prying the box apart. This drawer is fitted with a combination lock making it very secure.

There are two styles of mounting, either directly on the back board or at the side of the telephone by means of a mounting plate, as shown in the accompanying illustration.

Professor P. Zeeman, in a paper recently read before the Amsterdam Academy of Sciences (November 30, 1901), stated that he had been investigating the limits of resolving power obtainable by means of the Michelson echelon grating spectroscope, with an instrument consisting of thirty plates, each 7.8 mm. thick, set at steps of one mm. Testing by means of light sources in magnetic fields of gradually increasing intensities, he found that the resolving power was almost equal to its theoretical value.

The Chicago Automobile Show.

THE Automobile Show, with Henri Fournier in attendance, and Prince Henry of Prussia, have given Chicagoans much to talk about this week.

The Coliseum, in which the automobile show was held, was thrown open to the public on Saturday, March 1, but it was not until Monday that all the exhibits were thoroughly installed, and the crowds began to discover that the greatest automobile show ever held was doing business in Chicago. From that day to the end of the exhibition the throngs of admirers of the horseless carriage came and went, all pleased with the remarkable array of machines which had been gathered together for their inspection.

THE AUTOMOBILE SHOW AT THE COLISEUM, CHICAGO, ILL.

The Coliseum was appropriately decorated for the occasion, the floor space arranged in most convenient manner, the lights so placed as to give the very best effect, all of which resulted in making the visitor linger long in the grand building and enjoy every moment of his stay.

Nearly one hundred exhibits were installed, embracing everything pertaining to the automobile industry.

The electrical side of the show was exceedingly interesting. The manufacturers have been busily at work during the past year improving the appearance of their carriages and making them more substantial. It may be said that the electric carriages more than held their share of public attention and interest. The electric carriage is growing in popularity and will continue to do so as the public realizes the superior qualities of these machines compared with the intricate mechanism of the steam and gasoline vehicles.

The largest exhibit of the electrical part of the show was that of the Electric Vehicle Company, of Hartford, Ct.

A number of beautiful types of electric vehicles, including a straight front brougham, a Mark XIX cabriolet, a Mark III phaeton, a Mark XIX surrey, a Mark XIX tonneau, an Elberon victoria and a Seabright runabout, are shown.

All of the above types except the last three were seen at the show a year ago, and are well known and in common usage upon our public thoroughfares. In each instance a flexible running gear is provided, comprising axle members and rear members flexibly connected thereto. This company, on the heavier types of vehicles, uses the very desirable double-motor drive, permitting the use of solid rear axle and obviating all necessity for complicated balance gears. The motors are hung upon the rear axle, and the armature shaft bears a pinion, driving directly into the gear upon the driving wheels. A series parallel method of control is used in all cases, and a specially designed controller with a reversing switch gives three speeds forward and reverse. Both foot and emergency brakes are provided.

The Mark XIX tonneau is shown for the first time this year, and is a radical departure from anything produced up to the present time. The general lines of the body are decidedly Frenchy, and the battery is divided into two sections, one of which is borne under the seat, while the other is carried in the dash. A series parallel controller is employed, and the controller handle is provided with a thumb-press, which controls a lock that normally holds the controller handle in a vertical position. The forward speeds are secured by moving the handle forward from the vertical position. To go from the "go-ahead" to the "reverse" position it is necessary to depress the thumb-button on the handle.

The Elberon victoria and Seabright runabouts also have the batteries divided and certain advantages are obtained in thus distributing the weight more evenly over the front and rear axles. The general design, both from æsthetic and mechanical standpoints, has been worked out with great care and skill, and the result is shown in the production of a number of vehicles to which the general public has already taken very kindly.

The electric tonneau is designed to fill the want of a thoroughly first-class electric carriage that looks more like an automobile than the horseless carriage, and it is so arranged that the tonneau can be quickly removed and the vehicle converted into a single-seated carriage, or it can be equipped with a surrey back, or with a rumble for the coachman, all of which makes it a most attractive vehicle for those who are contemplating the purchase of an electric carriage for their several needs.

The Elberon victoria will take the place of the small victoria this company put out last year and which proved a very fashionable and attractive vehicle. It is easy of access, and, with or without the top, is a carriage that will at once command admiration from its general lines and easy riding. All of these electric vehicles are equipped with the Exide battery, which has given such wonderful results in the past year in automobile work and while the rated capacity of the carriage is shown to be forty miles it will greatly exceed that mileage under good conditions.

The International Motor Car Company, which manufactures electric vehicles

at its Indianapolis factory, had an interesting exhibit, consisting of a surrey, handsomely finished, weighing 1,800 pounds, equipped with two motors with a normal capacity of four horse-power, capable of standing an overload four horse-power additional; a road wagon with one motor of two horse-power, capable of a two-horse-power overload, and a handsome delivery wagon with the same motor equipment as the surrey. On all of these vehicles the National battery is used.

The Buffalo Electric Carriage Company exhibited its well-known Buffalo stanhope, a "Specialty Ideal for Doctors," a very beautiful and substantial machine and one which Mr. Babcock, the president of the company, says is giving the very best of satisfaction. The stanhope has broad seats and will carry three people. The company also makes a "Golf Brake," which has two seats and will accommodate six people. These carriages have six speeds forward and reverse. Its highest speed is fifteen miles per hour, but the greatest mileage is obtained at an intermediate speed of eight miles.

The storage battery used in this carriage has a capacity of fifty miles on one charge over level roads, and on a trial trip under normal conditions of roads, sixty-one miles was made at highest rate of speed. The battery can be fully recharged in three hours from any one hundred and ten volt circuit, direct current, at a cost not to exceed thirty-five cents.

The Baker Motor Vehicle Company, of Cleveland, Ohio, submitted its exhibit to the public with the following sentence which was prominently displayed: "We will leave you to judge." It was a beautiful exhibit which the Baker company installed, consisting of runabouts and stanhopes. Forty miles per charge; speeds, six, eleven and fourteen miles per hour; weight, complete with battery, 600 pounds; light in action, with the least resistance and friction, are the good points of the Baker runabouts. The Baker stanhope weighs 900 pounds, is graceful of design and elegant in finish.

The Porter Battery Company, of Waukegan, Ill., occupied a space showing various sizes of its batteries, and two vehicles equipped with same. The Porter battery is well known, and the company claims for it features which make it especially adaptable for automobile purposes.

The National Carbon Company, of Cleveland, Ohio, displayed a handsome collection of dry batteries, embracing the Auto cell and Columbia types. One feature of this exhibit which was of especial interest was a large Columbia cell of 2,000 amperes—the largest dry battery ever constructed.

Chicago Electrical Notes.

(By Our Special Correspondent.)

THE plant of the Electrolysis Proof Conduit Company, of West Pullman, was destroyed by fire on the night of February 25. The damage is estimated at $30,000. The cause of the fire is unknown. It is understood that the company will rebuild at once, and that the fire will in no way interfere with the filling of its orders.

Mr. G. H. Atkins, who for several years has been identified with the electric vehicle industry in the West, has been appointed manager of the Chicago office of the Electric Storage Battery Company. Mr. Atkins resigns the position of general western agent of the Electric Vehicle Company to take charge of this office. He is well known in electrical circles, having been connected with the General Electric Company in Chicago for about ten years.

On February 29 five horses were killed by a very peculiar accident which caused some comment among electricians in the city. The heavy rains had filled the streets with mud and water and horses crossing at a point on Twelfth street were subjected to shocks of sufficient strength to electrocute them. It seems that the trouble was caused by a defective insulation to one of the guy wires on the iron pole. This pole was set in an iron case which was filled with concrete. The current escaped from this pole at the earth's surface, and found, in the mud and water with which the pavement was covered, a conductor of the current to the track of the car line. The horses wading into this, with their front feet near the track and the rear near the pole, formed a circuit of less resistance and, therefore, got the severe shocks which promptly put them out of action. Five horses were instantly killed and two others knocked down. Much excitement was caused by the cry of "live wire," and the police were hurried out by a riot call sent in from the frightened district.

It is now said that the traction companies of Chicago, in order to secure an extension of franchises, will propose to pay to the city government, in lieu of taxes, ten per cent of their gross earnings. In 1901 the gross receipts of the Union Traction Company were $7,289,137, while the total receipts of the Chicago City Railway amounted to $5,900,271. Under the ten-per-cent proposition the companies would last year have contributed $1,318,940 to the city government, an increase of $680,900 over the amount of taxes actually paid the city. It is said that in the event that such a proposition as this is made there will be an effort to have twenty per cent of the gross earnings substituted for ten per cent.

The announcement that the Illinois Telegraph and Telephone Company has completed more than five miles of tunnels under the heart of the city of Chicago, and that the work will be rapidly pushed from this time forth, coupled with the statement that these tunnels were large enough to be used, not only for telephone wires but for mail and merchandise delivery tubes, has aroused certain of the aldermen of the city, and last week a resolution was presented in city council and adopted providing for a committee to examine these tunnels and see what size they were, to what purposes they were to be put, and whether there had been any infringement of the rights of the city.

City Electrician Ellicott, who is a member of the city council telephone committee, has stated that the ten-party line ought to be abolished. He says the Chicago Telephone Company has been educating the people to use these party lines to the detriment of the regular patrons, and that in consequence the entire system is retrograding. Mr. Ellicott says he thought the company was rapidly finding out that the party-line system or the nickel-in-the-slot telephone was a bar to good work. He declares that the committee would oppose the ten-party line and limit the number of users on one circuit to four in order to protect the patrons who pay the maximum price and use the telephones only for legitimate business purposes.

The reports recently circulated to the effect that the Yaryan and Evanston Illuminating companies, of Evanston, Ill., were to be consolidated and reorganized under a new franchise are without foundation in fact. I am reliably informed that the Evanston Electric Illuminating Company, which is owned by the Westinghouse interests in Pittsburgh, has not been sold and has not purchased the Yaryan plant, nor is it negotiating for it. As a statement to this effect was made in these "notes," I take this occasion to correct it.

Chicago, March 8.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

CORNWALL-TORONTO ELECTRIC ROAD — A charter has been given to Boston capitalists to build an electric line from Toronto to Cornwall and a line from Brockville through Smith Falls to Ottawa, in all about 350 miles. The fund for this purpose will be $8,000,000, and the work will be pushed to an early completion.

TRACTION, GAS AND ELECTRIC LIGHTING COMPANIES IN RHODE ISLAND ARE CONSOLIDATED—It has been announced that the Union Traction, capitalized at $8,400,000; Providence Gas Company, with $5,000,000 in stock, and the Narragansett Electric Lighting Companies, capitalized at $2,750,000, are united. United States Senator Nelson W. Aldrich, the president of the Union Traction Company, has been in Providence in consultation about the new company, the capitalization of which is not yet made public.

EVERETT-MOORE SYNDICATE HOLDINGS SOLD—By the action of the sales committees of the bankers' committee having in charge the affairs of the Everett-Moore Syndicate, nearly all the holdings of the syndicate in Big Consolidated Street Railway stock have been sold to the Andrews-Stanley interests. The actual number of shares of stock which will be turned over to the new management is 43,000. The Everett-Moore Syndicate will retain 2,000 shares. With the 27,000 shares which the Andrews-Stanley Syndicate now owns the new management will hold 70,000 shares and the controlling interest in the street railway property. Its interest will be 5,000 shares, more than half the total number of shares in the company, which is 135,000. The transaction involves $3,440,000, as the stock was sold at $80 a share. This, with the other properties which the Everett-Moore interests have disposed of, and the sale of the Detroit United Railway, which is proposed, will relieve the situation with the syndicate, and again, it is claimed, put its financial affairs on a practically sound basis. Besides the Big Consolidated Railway the properties that have already been sold are the Akron-Canton Interurban line, the Canton and Massillon City lines, and the Canton-Massillon Interurban line, together with the extension of the latter road to Navarre. The sale of the Detroit United Railway is expected to follow soon.

NEW WATER-POWER PROJECT—It is announced that definite efforts are to be made to the end of harnessing some of the natural water powers about Duluth. The city council, at a recent meeting, received an application from the Highland Canal and Power Company for a twenty-five-year franchise, authorizing it to erect and operate a water and electric power and light plant, and construct canal basins, pipe lines, etc. Within the next two years the company expects to spend something like $2,500,000 in constructing the necessary canals, reservoirs, and power plant, designed to furnish from 35,000 to 50,000 horse-power to turn the wheels of various industries at the head of the lakes. It hopes to begin operations by October 1, 1903, and is already making contracts to furnish power at that time. The lower part of the system will be developed first. This includes the Cloquet River and Wild Rice Lake, and the latter will be one of the reservoirs. Active work will begin this coming summer upon the dams and reservoir system. It is estimated that the first 25,000 horse-power will cost about $2,000,000. The price to consumers will range from $20 to $35 a year per horse-power for an alternating current delivered on the premises. The Highland Canal and Power Company is a subsidiary corporation of the Northwest Power and Transportation Company, a New Jersey corporation, with a paid-up capital of $5,000,000.

NORTH RIVER TUNNEL TO BE FINISHED—The New York & Jersey Railroad Company was incorporated several weeks ago under the laws of both New York and New Jersey to complete the tunnels under the North River, connecting New York city and Jersey City, which were begun many years ago by the Hudson Tunnel Railway Company and subsequently abandoned. The northerly of the twin tunnels was completed, before the abandonment, for a distance of 3,920 feet and the southerly tunnel for about 600 feet. It will be remembered that a serious disaster, causing the loss of several lives, coupled with financial embarrassment, caused the abandonment of the work. The officers of the new company are William G. McAdoo, president; W. G. Oakman and E. C. Converse, vice-presidents; Henry A. Murray, treasurer, and Charles M. Jacobs, chief engineer. The board of directors includes Messrs. E. H. Gary, of the United States Steel Corporation; Anthony N. Brady, E. C. F. Young, G. Tracy Rogers and other gentlemen of equal prominence in financial and railway circles. The capital stock of the new company is $8,500,000, divided into $3,500,000 of six per cent noncumulative preferred stock, which is now issued, and $5,000,000 of common stock. The charter permits the company also to issue $7,000,000 of five per cent bonds, of which $4,500,000 have been issued. Of the rest of the authorized bonds, $2,000,000 are reserved for the purchase of additional property. The plans of the company include the immediate completion of the north tunnel and the erection of surface terminals in Jersey City and New York, at which connection will be made with trolley cars of the North Jersey Street Railway Company and other New Jersey corporations and the Metropolitan Street Railway Company on the New York side of the river. In all, 1,580 feet of the tunnel remain to be built, and this is immediately to be finished, equipped with two tracks and operated by electricity. Pending the completion of the second tunnel cars of special design will have to be used in the north tunnel. Electrical traction, of course, will be used. It is expected that the work can be finished inside of two years.

ELECTRIC RAILWAYS

TROY, N. Y.—The survey of the new electric road to connect Troy and Williamstown is about completed. The plans provide for fifty miles of new road.

ROME, N. Y.—The common council of Oneida has granted the Street Railway Company of that city a franchise to build a trolley road from the east to the west line of the city, with a branch to the central station. Work must be begun by April 15 and completed by November 1.

DECATUR, ALA.— Mr. J. T. Cross, an owner of electric railways in Tennessee and Kentucky, has been in Decatur recently for the purpose of securing the holdings of the Decatur Railway Company. Should he be unsuccessful in this direction, it is said that he will seek a franchise to construct and maintain an independent line.

TOLEDO, OHIO—Colonel J. C. Bonner and Julian Tyler are home from Fort Wayne, where they secured the extension of and more privileges under their electric railway franchise in that city. The franchise covers four and one-half miles of track through the city, and belongs to the Ohio & Indiana Air Line road, which has acquired control of the Bryan Air Line.

ATLANTIC CITY, N. J.—Operations have been commenced by the Chelsea Heights Traction Company. One line will run from the ocean front at Albany avenue to Chelsea Heights and another from the board walk at Florida avenue across the Thoroughfare and thence to Pleasantville. It is also proposed to run a line from Chelsea Heights to connect with the Pleasantville extension.

DES MOINES, IOWA—It is announced that improvements in the Polk street railway lines will be in the shape of an extension of the Third and Fourth avenue line to Mercy Hospital, and the extension of the West Ninth avenue line to the new hospital near Crocker Woods. An effort will also be made to complete the line from Flint Valley to Ankeny and Polk City during this year.

PHILADELPHIA, PA.—The Union Traction Company, which has the right to construct a trolley line on the new boulevard to be opened in the northeast part of Germantown, is making plans for this line which will connect Glenside with either the Germantown avenue or York road trolleys at Mill street or Chelten avenue. Trolley connections will also be made from Glenside to Willow Grove.

DETROIT, MICH.—The executive committee of the American Street Railway Association met at the Hotel Cadillac, Detroit, Mich., recently, and perfected arrangements for the annual convention to be held there October 8, 9 and 10. The officers of the committee were: H. H. Vreeland, New York, president; C. W. Wasson, Cleveland; C. E. Foster, Boston, and H. M. Sloan, Chicago, vice-presidents; T. C. Pennington, Chicago, secretary and treasurer.

ELECTRICAL SECURITIES

Although the market generally was characterized by dull and professional dealings, there has been a moderate and somewhat irregular improvement, as a comparison of conditions of a week ago show that the tendency has been upward, and some good gains for the week have been made.

Much of last week's apathy, however, can be traced to the interruption of business caused by the damage done by storms to telephone and telegraph wires, the delays in the mails, and also the absence from the city of many prominent financiers and operators.

While the attitude of the administration at Washington in regard to corporations is such as to cause grave concern in financial circles, the disposition thus far displayed will result in no permanent harm. The Northern Securities situation, and its cognate matters, and the year's harvest still remain the most important questions, the solutions of which will have largely to do with the year's drift of prices in the stock market. The general commercial prosperity continues, as is shown by recent data of conditions in all industrial centres. Railroad earnings are not so universally favorable as a short time ago, but most systems show increased earnings, even over last year's figures. An impartial survey of the situation at large reveals nothing to indicate that any permanent check has been administered to our industrial expansion, and in the local market the stability of a number of high-grade securities has revealed the existence of a continuing investment demand of unsuspected extent.

ELECTRICAL SECURITIES FOR WEEK ENDING MARCH 8.

New York:	Closing.
Brooklyn R. T.	64
Con. Gas	221
Gen. Elec	299½
Man. El	131
Met. St. Ry	168
Kings Co. Elec	191
N. Y. & N. J. Tel. Co	169
Telep., Tel. & Cbl. Co	5

General Electric rose to record conditions during the week, going up to 302, and then settling to 300. This was probably caused by the continued talk that the capital stock is to be increased, with incidental and valuable stock privileges to shareholders.

The Metropolitan Street Railway has announced a plan for the establishment of a pension system for superannuated employés. The maximum age is seventy years, but those whose ages range from sixty-five to sixty-nine may be retired under pension if found incapacitated.

It has been stated that enough proxies have been secured to assure a favorable vote on the question of leasing the holdings of the Metropolitan Street Railway.

Boston:	Closing.
Am. Telep. & Tel	161
Edison Elec	260
New Eng. Tel	141
Mass. Elec. pf	96¾
Westing. Mfg. pf	91
Western Telephone & Telegraph	105½

The *Wall Street Journal* says: "Rumors relating to a prospective stock issue by the American Telephone and Telegraph Company as a basis for the advance in price of stock are believed to be premature. Of course, it is known that the American Telephone and Telegraph Company will be obliged to call upon stockholders before the close of the year for new money to meet extensions and acquire its proportion of new stock issued by its subcompanies, but it is not believed that this new stock issue will come before July. The company is now said to be 'flush with money.'"

Philadelphia:	Closing.
Elec. Co. of America	7
Philadelphia Elec	5
Union Traction	39½
United G. I. Co	120
Elec. Stor. Bat. c	63
Elec. Stor. Bat. pf	65

The annual meeting of Philadelphia Electric stockholders will be held in Camden, April 9. Books close March 19 and reopen April 1.

It appears to be settled that the Union Traction stockholders will ratify the lease of the road to the Consolidated Traction Company.

Chicago:	Closing.
Central Union Tel	40
Chicago Edison Light	169
Chicago Telep	178
Metropolitan El. pf	90½
National Carbon	19½
National Carbon pf	84
Union Traction	14½
Union Traction pf	48¾

Directors of the Chicago Telephone Company have reduced the dividend rate from twelve per cent to ten per cent per annum. They declared a quarterly dividend the amount being $2.50 per share instead of $3, as paid formerly. The dividend is payable April 1 to stockholders of record at the close of business March 27. There are various reasons for the reduction of the Telephone dividend rate. One is the increase in taxation, another the recent decision of Judge Tuley limiting the price of telephone service and a third the increase in the amount of stock. The company has already issued $1,000,000 of new stock this year and will add $2,000,000 more. The amount now outstanding is $10,000,000, and the additions to be made will raise the figure to $12,000,000. It is doubtful if the earnings during the year, after the deduction of the increased charges, would be sufficient to maintain the old rate.

To provide extra terminal facilities, the Metropolitan Elevated Railway Company has purchased property on Market street at an aggregate cost of $771,000. Metropolitan stocks were firm on the stock exchange as a result of this move.

TELEPHONE AND TELEGRAPH

PITTSBURGH, PA.—The stockholders of the Central District Printing and Telegraph Company at a meeting recently held in Pittsburgh, voted to increase the capital stock from $7,500,000 to $10,000,000.

ANTIGO, WIS.—The Antigo Telephone Company has completed arrangements for a long-distance telephone service *via* Wausau. The material is already on the ground and operations will commence as soon as weather will permit.

VALLEY, NEB.—At a meeting of the citizens recently, it was decided to form a stock company with a capital of $10,000 to establish an independent telephone company, eventually to connect with other independent lines throughout the state.

TOLEDO, OHIO—The Central Construction Company, which is performing the building work for the Home Telephone Company, is making splendid progress, as shown by a report submitted by the engineer in charge. The company has 5,513 three-year contracts with telephone subscribers and expects to have its exchange in good operation early this coming summer.

OTTAWA, OHIO—The Columbian Telephone Company, of Chicago, Ill., will locate in Ottawa the coming summer and erect a plant for the manufacture of telephone supplies, switchboards and telephones. A stock company consisting of local business men has been organized with a capital stock of $250,000 and work will be commenced at once preparatory to erecting the factory.

ELECTRIC LIGHTING

CHICAGO, ILL.—The electric light plant at Oak Park has been destroyed by fire at a loss of $100,000.

SHEFFIELD, ALA.—The application of F. C. Brumbach for an electric light franchise for Sheffield has been declined by the city council.

BAY CITY, MICH.—The Bay City Gas and Electric Company has been awarded the Essexville electric light franchise, and will supply both the village and private citizens with light and power.

MANSFIELD, PA.—The borough council of Mansfield has closed a contract with the Electric Light Company for lighting the streets of the borough for ten years; the contract price is $1,000 a year.

ANNAPOLIS, MD.—The state building commission is said to be looking around for a desirable location to establish an electric light plant and power-house in the city. Several localities have been declared available.

SHERIDAN, WYO.—The Sheridan Electric Light Company has sold the entire plant to an eastern company. The plant is one of the best paying institutions in the city and the improvements contemplated will greatly increase its value.

COLORADO SPRINGS, COL.—Local merchants have subscribed about $25,000 to the funds started in this town recently for the purpose of establishing an electric light plant to furnish light and power to storekeepers only. It is believed that not much over $30,000 will be needed for the proposed new plant, and the subscription list will probably be closed very soon.

INDUSTRIAL ITEMS

THE CENTURY LAMP COMPANY, Bellaire, Onio, has issued two catalogues known as numbers 3 and 5, the former of which is devoted to incandescent lamp shades and the latter to inner globes for incandescent lamps.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has just issued circulars describing the Eaco visual signal metallic circuit switchboards, and the Eaco country or party-line switchboards for metallic or grounded circuits.

THE NATIONAL CONDUIT AND CABLE COMPANY, manufacturer of bare copper wire and cables, paper-insulated cables and cement-lined conduits, has removed its Boston office to the Delta Building, Post Office Square. The eastern manager is Mr. F. S. V. Sias.

THE CHARLES E. DUSTIN COMPANY, New York city, makes a specialty of securing for its patrons a good line of slightly used, but high-class machinery. The company has ready for immediate delivery some fine apparatus, and solicits information from prospective users of electric power.

THE WHEEL TRUING AND BRAKE SHOE COMPANY, Detroit, Mich., is sending out a unique reminder in the shape of a cardboard disc, which introduces its trade expression, "round and true," to which is attached an address tag bearing an illustration of this device and a short catchy advertisement phrase.

MR. MAX LOWENTHAL, a well-known electrician, has been appointed electrical engineer of the Prometheus Electric Company, New York city. This company manufactures electric resistances, heating and cooking apparatus on a new system which, it is claimed, possesses some decided advantages.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, on and after March 15, will be located at Bridgeport, Ct., the principal office and entire manufacturing plant being removed from Hartford. The Bridgeport, Ct., address will be 1421 State street, but no change will be made in the Chicago or New York offices.

THE O. K. SPECIALTY MANUFACTURING COMPANY, Garrettsville, Ohio, has perfected a new automatic time switch for automatically turning on and off electric lights in electric signs or in show-windows. The switch may be so adjusted that it may be set in such a manner as to turn on or off any or all of the lights at a given moment.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has opened a branch office in Room 204, Keystone Telephone Building, corner Second and Sansom streets, Philadelphia, where a full line of samples will be on exhibition and where any information regarding business matters generally, connected with the company, will receive prompt attention.

THE CUTTER ELECTRICAL AND MANUFACTURING COMPANY, Philadelphia, Pa., is issuing a very unique and useful polyglot catalogue. The company's I-T-E circuit-breaker is described in parallel columns in English, French, German and Spanish. The catalogue comprises eighty-six pages and is replete with numerous illustrations of apparatus and methods of installation.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is constantly striving to bring its generators to such standards as shall give a wide range of outputs and still maintain speeds that correspond to those chosen by most prominent engine builders. Orders recently placed aggregate some 3,625 kilowatts capacity for twenty engine-type generators.

MR. GEORGE A. WADDELL has been appointed chief electrician of the Merchants and Miners' Transportation Company, Baltimore, Md. Mr. Waddell is a graduate of the American School of Correspondence, of Boston, Mass., and adds another to the list of those who, coming from such institutions, are able to make a good place for themselves.

THE SHELBY ELECTRIC COMPANY, of Shelby, Ohio, is distributing an illustrated pamphlet descriptive of the advantage of the Shelby type of incandescent lamps, which type of lamps it is claimed delivers from sixty-six and two-thirds per cent to eighty-five per cent of the rated candle-power of the lamp through the tip, at the same time delivering the rated illumination from the other points of the lamp.

THE HAINES & NOYES COMPANY, Chicago, Ill., has closed during the past month a number of good contracts, among which the following are fair specimens: Hotel Freemont, Cal., 130-drop switchboard and 130 telephones; Conservative Life Building, Los Angeles, Cal., ninety-drop switchboard and ninety telephones; in Evanston, Ill., a large apartment-house with thirty-five telephones and an apartment-house system.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has several very interesting working exhibits at the Charleston Exposition. One is the switchboard through which all the lighting and power service at the exposition is controlled. Another interesting exhibit is a five-horse-power single-phase power motor, directly geared to one of the fire service pumps provided by the Exposition company. Other interesting special installations are several automobile charging outfits, comprised of single-phase motors direct coupled to shunt-wound generators, these being utilized for the charging of the automobile batteries for all the electrical vehicles operating on the exposition grounds.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, has recently made a change in the management of the Philadelphia office, located at 612 Arch street. Mr. P. B. Fenlon is no longer manager of that office, having been succeeded by Mr. O. G. Smith, who has heretofore been in the office of the air compressor department. A change has also been made relative to the Pittsburgh office. Mr. A. L. McClurg, who for the past six years has been connected with the Harrison Safety Boiler Works, has made an engagement with this company; he will make his headquarters in the Pittsburgh office as a salesman of feed-water meters, pumps, etc., working in connection with Mr. E. F. Austin, who is the Pittsburgh sales agent of the Stilwell-Bierce & Smith-Vaile Company.

NEW INCORPORATIONS

COLUMBUS, OHIO—The United Telephone Company. $250,000.

MILWAUKEE, WIS.—Milwaukee Electric Company, Milwaukee, Wis. $200,000; capital in Illinois, $800.

NEW HAVEN, CT.—The New Milford Power Company has filed a certificate of increase of capital stock from $100,000 to $1,000,000.

JEFFERSON CITY, MO.—Mineral Belt Telephone Company, of Joplin. $300,000. Incorporators: John W. Layne, E. J. Layne, J. L. Moore and others.

OMAHA, NEB.—The Stanton Electric Light Company, of Stanton. $10,000. Incorporators: Harry D. Miller, Arthur W. Forbes, Frank C. Raabe and Frank L. Sanders.

INDIANAPOLIS, IND.—The Manufacturers' Belt Railway Company, of Kokomo. $50,000. To build a belt road around Kokomo as part of the Lake Shore and Lake Erie systems.

SPARTA, TENN.—The Sparta Electric Light and Power Company. $5,000. Incorporators: J. A. Eagle, J. L. Dibrell, C. P. Hutchinson, Frank Dibrell, W. T. Smith, S. S. Dibrell and T. K. Williams.

TRENTON, N. J.—The American Elevated Railway Company. Increasing its capital stock from $100,000 to $5,000,000. The certificate is signed by Osborne Tougleton, president, and George H. Cook, secretary.

DOVER, DEL.—The Brandywine Railway Company, of Wilmington, to construct a railway in the city of Wilmington, extending along the Brandywine creek to Pine street, Twenty-third street, Washington street, Thirtieth street and Tatnall street. $150,000.

LINCOLN, NEB.—Blair Telephone Company; $15,000; incorporators: Thomas Lippincott, W. M. Martin, Joe S. Cook, John W. Sas and Peter M. Tyson. Stella Telephone Company; $3,200; incorporators: C. H. Thomas, H. E. Clark, S. P. Hinds, J. H. Overman, S. E. Timmerman, H. B. Woodring, D. L. Harris and Guy Harris.

TRENTON, N. J.—The American District Telegraph and Messenger Company. $50,000. Incorporators: F. L. Blendinger, of Rutherford; C. S. Shivler, of Brooklyn, and J. C. Willever, of Millburn. The office of the company is at 76 Montgomery street, Jersey City, and J. B. Bertholf, manager of the Western Union Telegraph Company's system in Jersey City, is the agent.

YORK, PA.—Lancaster Valley Electric Light Company. $60,000, paid in. This company has purchased the Manheim Electric Light, Heat and Power Company, the Ephrata Electric Company and the Mount Joy Electric Light, Heat and Power Company. The directors of the new company are as follows: Ex-Senator William H. Sponsler, of Pittsburgh; Ed. R. Sponsler, Esq., of Harrisburg; C. Taylor Leland and H. L. Chandler, of the banking firm of Chandler & Leland, Philadelphia; S. N. Bailey and L. U. Bailey, of Dillsburg.